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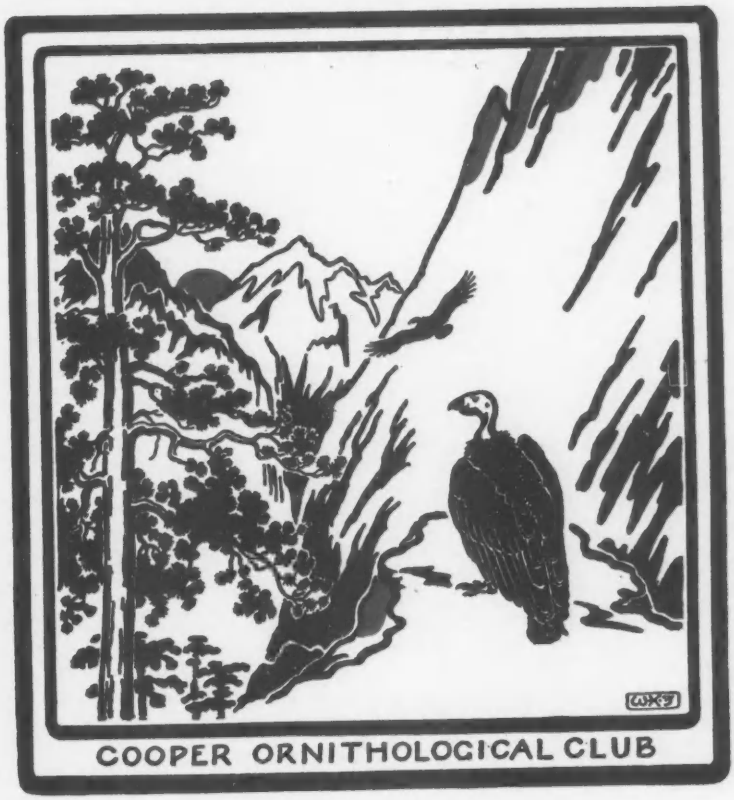
THE CONDOR

A Magazine of Western Ornithology

Volume 47 March-April, 1945 Number 2



COOPER ORNITHOLOGICAL CLUB

THE CONDOR

A Magazine of Western Ornithology

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THE CONDOR

VOLUME 47 MARCH-APRIL, 1945 NUMBER 2

THE NESTLING OF THE SOOTY SHEARWATER

By L. E. RICHDALE

In an earlier paper on the breeding habits of the Sooty Shearwater (*Puffinus griseus*) in New Zealand (Richdale, 1944b:102), it was necessary to withhold the story of the nestling. Accordingly, this paper will deal solely with the young shearwater from the time it begins to hatch until it leaves its island home. Data used herein were collected chiefly on Whero Island in the period from December 20, 1941, to March 14, 1942, but they are supplemented by important details gathered on a later trip of six weeks in 1943-44. In order to elucidate still further the behavior of the nestling, reference has been made to other species of petrels studied.

Several points in the paper mentioned above need discussion and elucidation. The suggestion (Richdale, 1944b:99-100) that the 1943-44 season was a late one proved wrong, for the hatching dates, as noted in table 1, were normal. In fact, three chicks hatched a day earlier than in any of the preceding years. This means that my estimation (page 100) of the average incubation period of eight weeks is correct. It will be noted (page 99) that I found no eggs in 100 burrows on Taieri Island, about 20 miles south of Dunedin, on November 20, but 24 were recovered on November 27. From November 20 to January 17 is 58 days, which means that average incubation is not longer than this and according to further information given on the same page very little less than 58, and certainly more than 51 days. Finally my remarks (page 100) that the span of egg-laying is short are correct. Hatching on Whero Island in 1943-44 of 59 chicks occupied 18 days so that eggs must have been laid in a similar or slightly shorter period.

For assistance in the preparation of this and my earlier paper I am grateful to Professor B. J. Marples of the University of Otago and to Messrs. L. J. Cameron and C. A. Fleming, both of Wellington, New Zealand.

HATCHING

Literature contains very little information relative to the day of hatching, and certainly the mythical December 25 (Cockayne, 1909:38) is far from correct. I believe the main reason for this lack is the paucity of observations on the breeding grounds at the right time. Marples (1941:6) notes that on Taieri Island an egg was chipping on January 17, 1941. From that date the final emergence of the chick could easily have taken two, or even three days. Archey and Lindsay (1924:189) found that hatching began on the Chatham Islands on January 15. Buller (1888:233) states that when he visited Whale Island in the Bay of Plenty about the middle of January he observed well-grown nestlings of *Puffinus griseus* with black quills and tail feathers protruding through their down. This statement has been copied by Bent (1922:87). In this matter it appears obvious that Buller is confused with *P. gavia* (= *reinholdi*). The field records of Falla (1934:253) and Oliver (1930:126) indicate quite clearly that the nestling of

gavia is at this stage in its growth by the middle of January, whereas that of *griseus* is not even hatched.

The information given in table 1, dealing as it does with 88 chicks over a period of four seasons, indicates conclusively the range of hatching dates. The records for the first few years for various reasons are somewhat meager. When I left the island on January 26, 1943, there were still 8 eggs whose hatching dates could not be estimated. A proportion of these were probably addled. In 1943-44, however, I found 59 eggs which hatched and gave a definite hatching range from January 17 to February 4, a period of 18 days. Seventy-two or 83 per cent of the eggs hatched in the 10-day period from January 19 to 28. There were 6 other eggs which proved on examination to be addled, making a little more than 9 per cent for this class.

Table 1

Hatching dates of Sooty Shearwater chicks

Class interval	Number of hatchings				
	1940-41	1941-42	1942-43	1943-44	Total
Jan. 17-18			1	6	7
Jan. 19-20	1	6	2	8	17
Jan. 21-22	1	2	2	12	17
Jan. 23-24	1	2	1	12	16
Jan. 25-26	1	4	2	4	11
Jan. 27-28			3	8	11
Jan. 29-30				4	4
Jan. 31-Feb. 1				3	3
Feb. 2-3				1	1
Feb. 4				1	1
Totals	4	14	11	59	88

Though it is difficult to ascertain just when the shell is first chipped, close observation at several nests indicated that after chipping began the chick took at least four full days to emerge. A case in point is the following. At 4 p.m. on January 21 I visited nest 12 for the first time since January 2 and found nearly a square inch of shell starred, but there was no hole. Guided by my experience with the eggs of other species I made a note in my book that the chick would be out next day. This was not to be, for on the succeeding two days there was no external evidence of any progress. At 2 p.m. on January 24 there was a small hole through which the chick's beak could be plainly seen. Next day at 1 p.m. the hole was much larger, allowing me to see clearly the whole of the beak. At 10:30 p.m. the chick had emerged and, except for a few tufts near the tail, the down was quite dry. It was inert and would not squeak. This chick took at least four days to emerge from when I first noticed the chipping; moreover, this cannot be an extraordinary case for I have several others which, to my knowledge, were chipping for at least three days.

Lockley (1942:35, 85) has noted that chicks of the Manx Shearwater (*P. puffinus puffinus*) emerged after two days' chipping. This period is at least 3 days for the Royal Albatross, *Diomedea epomophora sandfordi* (Richdale, 1942:255), apparently only 24 hours for *Pelagodroma marina maoriana* (1943b:108), 2½ days for *Pachyptila turtur* (1944c:37), and 3½ days for *Pelecanoides urinatrix* (unpublished).

The chick, once it is hatched, quickly dries. I have a record of a chick which had not emerged at 3:10 p.m., but at 7 p.m. was clear of the shell and entirely wet except for a few tips which were dry. It did not squeak, coughed no oil, had its eyes open, and weighed 66 grams. At 10 p.m. it was quite dry and fluffy, still had no voice, coughed no

oil, and weighed 60 grams and consequently had not been fed. At 1 a.m. it was still 60 grams but I could not be sure that it had not received a small meal. Nine hours later, it was 62½ grams and therefore had definitely been fed about 12 hours after hatching. There is no removal of the egg shells after hatching, for they are just crushed, as is true with the Royal Albatross, also.

I do not believe that the Sooty Shearwater leaves its eggs uncovered as is the custom with the different species of Storm Petrel (Lockley, 1932:210; Gross, 1935:391; Ainslee and Atkinson, 1937:239; Roberts, 1940:163, fig. 7; and Richdale, 1943b:102). I have one record of an egg being left four days and subsequently hatching, but I have decided that the desertion was due to my activities. Lockley's favorite pair of Manx Shearwaters (1942:33) did not leave the egg cold for a single day either. It is interesting to note that the Laysan Albatross, *Diomedea immutabilis* (Hadden, 1941:211-212), leaves the eggs uncovered for four or five days without hatching being affected.

THE CHICK

As already stated, the earliest chicks begin to hatch on Whero Island about January 17. Though the down dries quickly the chick lacks the appearance of a fluffy little ball, as is characteristic of chicks of *Pelagodroma* and *Pachyptila*. The down is relatively shorter, being 20 mm. on the back and only 8 mm. on the head, and the bill is not lost in the down. The forehead is covered to the base of the bill over which the down tends to fall. The bill itself is slightly curved convexly in somewhat the same manner as that of the young Royal Albatross chick (Richdale, 1939:fig. 3). Most of the bill is a uniform light blue gray (39h) in color with three lighter shades as the tip is approached along the culmen. The ramicorn is a light violet gray (40n). The rest of the lower bill is light blue gray (39h) with a lighter shade at the dertrum, a term applied to the tip of the lower mandible. The egg tooth is white. At hatching the eye is fully open. The color chart used for describing the down and other features of the chick was Radde's International Farben-Scala. The figures and numbers in parentheses are those used in the chart whereas the description in words is my own description of colors corresponding to Radde's symbols.

As near as I could match it, the down of the dorsal parts is a dark carmine gray (42d). The under parts are a medium neutral gray (31k) with traces of a lighter shade (31s) here and there. In front and at the sides the tarsus is a light violet gray (40σ), but the back is much darker (40g). The toes are the same two colors on top and underneath, respectively, and the webs are pinkish. At the tips the claws are whitish and on the ridges there is a bluish tinge (30p).

The chick soon overcomes its initial inertness and bites severely, at the same time coughing up very vile smelling oil; but it seldom squeaks. Frequent feeding during the first week will give the belly a rotund and taut appearance. Fleas are not long in making their presence felt and up to a dozen ticks may be found adhering between the toes.

By the beginning of the second week the average chick, though showing little outward change, will have added considerably to its hatching weight of from 60 to 80 grams. There is a perceptible elongation of the head as the long down of the forehead now does not overhang the base of the bill. The down of the upper parts appears slightly lighter in color probably because it is not so compact. The tarsi and feet are decidedly darker in color. The egg tooth is still present and the chick continues to bite severely and to cough up oil. On the eighth day the sheaths of the secondary down feathers are just visible on the scapulars. In most of the other species of sea-birds I have studied this appearance occurs on the seventh day, but with *Pelecanoides* it is the sixth day.

The mesoptyle quickly covers the body, appearing in normal chicks that are being well fed on the tenth day on the forearm and on the thirteenth on the hand. On the basis of nine records, the egg tooth disappears between the ages of 11 and 22 days.

In the third week the bill has darkened a little more and the unguis (tip of upper mandible) and the dertrum have become sharply defined. The face and bill are longer, resembling more those of an adult shearwater. The mesoptyle has grown so much that the protoptyle is long and loose, giving the chick a beautiful appearance. The various colors of the tarsi and feet have darkened still further. By this time the chicks which have all been handled daily have become tame, but there are considerable individual differences in behavior.

Up until the fifth week there is very little external change. The chick elongates in body and becomes fluffier and still more beautiful. Many of the chicks have been undergoing long periods of fasting interspersed with short intervals of heavy meals. The duration and number of these fasts have had an effect on the growth rate of the feathers. Between the ages of 31 and 35 days, in normal chicks, feathers appear on the scapulars and quickly spread all over the body. Two days later they will be noted on the forearm and three days after that on the hand. As the protoptyle falls off, the mesoptyle is seen to be slightly darker than the former.

When I left the island on March 14 the oldest chicks were in their eighth week. The growing feathers were loosening the down. Two of the chicks acquired tails on the 49th day and two others on the 50th day. In the most advanced chick and the one which received the most food, the primaries were just protruding through the down on the 52nd day.

The following table provides data which can be utilized by other workers to enable them to estimate the age of Sooty Shearwater chicks found on areas they may visit. These are records of normal chicks which were vigorous, fat, and healthy. It must be remembered that any interference with the chick's food supply or with its health will increase the periods given in the table. These differences are more in evidence as the chick gets older.

Table 2

Data for estimating age of shearwater chicks

Age in days	Remarks	Number of birds
8	Mesoptyle on scapulars appears	9
10	Mesoptyle on forearm appears	9
13	Mesoptyle on hand appears	7
11 to 22	Egg tooth disappears, average 17½ days	7
31 to 35	Feather quills on scapulars appear	7
33 to 37	Feather quills on forearm appear	7
36 to 40	Feather quills on hand appear	7
49 to 51	Feather quills on tail appear	4
51	Tips of primaries show through down	1
38	Length of longest primary, 3 mm.	
41	Length of longest primary, 12½ mm.	1
44	Length of longest primary, 22½ mm.	

Of the activities of chicks from March 14 to May 9 I have no records from personal experience. From April 1 the mutton-birders are on the islands pulling the fat, fluffy chicks from the burrows and killing them. From May 1, the chicks are caught on the surface at night. When on Whero from May 10 to 17, 1941, I discovered that the only four burrows under observation which contained chicks the previous January were

empty; three contained down feathers, indicating that the chicks had evidently survived. The youngest of these was hatched on January 25 and the oldest on January 20. The former therefore left the burrow in something less than 106 days. On the nights of May 11 to 16 I saw 12 chicks on the surface, the majority still with varying amounts of down adhering. The chick shown in figure 9 carries the greatest amount and may not have flown for at most another 10 days, that is, May 21.

From May 11 to 21, 1942, I was on Herekopare Island while the mutton-birders were at work. Unfortunately, it was a very poor season when over the whole Stewart

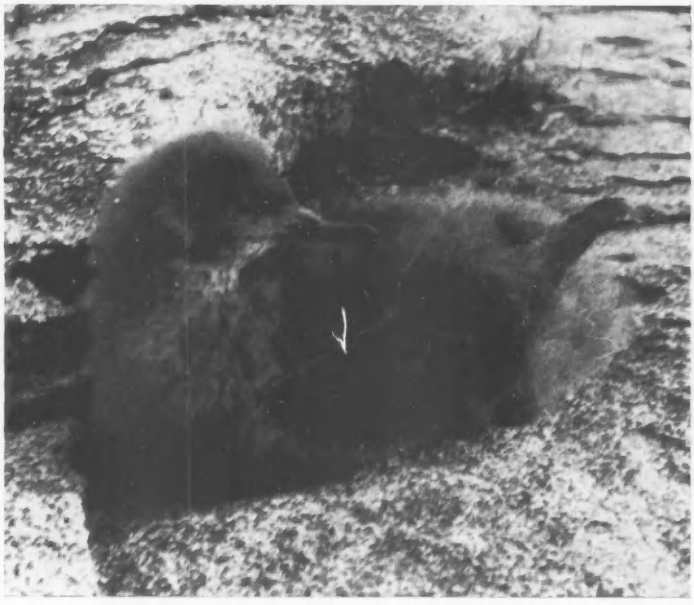

Fig. 9. Young Sooty Shearwater caught outside the burrow at night on May 11, 1941. This is about ten days from time of flying.

Island area only about 50 per cent of the normal catch was acquired. Only 37 chicks were caught in that period, 13 of these on May 17 and none at all for the remaining three nights. Ten of these 13 were clear of down. In this section I am not considering what the Maoris call *kihakas*. These are very light birds abnormally covered in down which are found toward the end of every mutton-bird season wandering about on the surface at night; they never survive to leave their island home.

Reports of the Maoris on the most thickly populated islands with reference to the 1943-44 season infer that button-birds were no longer available after May 13. This was, according to them, most unusual and to me seemed to indicate that the chicks were fed more regularly that year.

It appears then that nestling shearwaters begin to fly from the last week of April to approximately May 21. This means that they are ashore a minimum period of 95 days if my estimates are correct. Of course, the individual range of age at flying will

vary considerably and might be as much as three weeks. In the Royal Albatross, for instance, I have recorded the range from 220 to 251 days (1943b:337), in *Pachyptila turtur* from 44 to 55 (1944c:165), in *Pelecanoides* from 47 to 59 (unpublished), and in *Pelagodroma* from 52 to 67 (1943b:335). For the Manx Shearwater, Lockley (1942: 103) gives 72 days as the nestling stage. If this were the case in the Sooty Shearwater the Maoris would find chicks flying on arrival at the islands on April 1. This does not occur.

ATTENTIVENESS OF PARENTS

The most outstanding aspect of the relations of parent and chick is the length of time chicks are left unfed.

Table 3

Presence of adult with the chick during the day

Age in days	Nest									
	1	2	3	4	5	6	8	9	10	11
1	ad[1]	ad	ad	ad	ad	ad	ad	ad	ad	ad
	fd	fd	fd	fd	fd	fd	fd	fd	fd	fd
2	nad	ad	ad	ad	ad	ad	nad	nad	ad	nad
	fn	fn	fn	fn	fn	nfn	?	fn	fn	fn
			fd	fd	nfd	fd			nfd	
3		ad	nad	nad	nad	nad	ad		nad	ad
		nfn	fn	fn	fn	fn	?		fn	fn
		nfd								nfd
4		nad				ad	nad			nad
		nfd				fn	?			fn
5						nad				
						fn				
6						ad				
						fn				
						nfd				
7						ad				
						fn				
8		ad				nfd				
		fn				nad				
		fd				fn				

Key: fn, fed during previous night. nfd, not fed during day.
nfn, not fed during previous night. ad, adult present.
fd, fed during day. nad, no adult present.

In the foregoing table, for ten nests, I have recorded the occurrence of the parent with the chick in the daytime in the first few days following hatching. After the occasions listed, the parent was never found again with the chick in the first 52 days when I was present on the island. A parent was always in attendance during the first daylight hours after hatching, and in every case the chick was fed before 9 p.m. that day. On the second day only six of the ten chicks under observation were attended by a parent and eight of the nine that were being weighed had been fed. On the third day only three had adults with them but two of these chicks had been alone the previous day. With the exception of two chicks the parents were not present again during the day. With one of these exceptions (nest 2) the parent was again in attendance on the eighth day; the chick after having received a substantial meal during the night was again fed in the daytime.

The chick of nest 6 had a parent with it five times during the first seven days of its life. At 9 p.m. on its first day, chick 6 weighed 101 grams—an enormous weight—and

must have been fed recently. On the following day at 9 a.m., its weight was down to 93 grams, an indication that unlike the other chicks, it had received no food during the night. At 9 p.m. that day its weight had advanced to 111 grams, indicating that it had received a meal that day. The weight of 113 grams on the third morning seemed to prove that the second parent had not visited the nest, otherwise the meal would have been considerably heavier, probably nearer 40 than 2 grams. On the fourth morning the chick's weight had risen to 149 grams from 108 the night before and the parent, probably the second one, was with it during the day. Next morning it was alone and weighed 160 grams, this being 22 grams in excess of the previous night. On the sixth morning the weight had risen to 212 grams from 149 grams twelve hours earlier, and although the parent was again present no meal was delivered during the day. On the seventh and final day an adult was again present and the chick weighed 255 grams, having advanced from 194 grams.

This chick certainly received good attention. The weights at 9 p.m. on the seventh day for the other seven chicks averaged 135 grams and ranged from 79 to 187 grams. Further, chick 6 registered the heaviest weight of all the chicks for the whole period of my field study, being 1070 grams on its 47th day. The good meals it received early in life may have accounted for this.

My method of discovering whether or not a chick had been fed was to weigh it at 9 a.m. and 9 p.m. each day. Of all the petrels I have studied in this manner—Royal Albatross (1939:475-483 and 1942:255-262), *Pelecanoides* (1943a:35-36 and unpublished data), *Pelagodroma* (1943b:112), *Pachyptila turtur* (1944c:41)—the Sooty Shearwater seems to spend the least time with its nestling during the day. *P. turtur*, however, in this respect does not lag far behind.

Lockley (1942:37, 38, 73) mentions two cases of the appearance of the parent with the chick during the day. In the first, the chick was attended daily for the first six days and then again three days later for the last time. In the second case another chick was attended daily up to the eighth day with the exception of the sixth day and then not at all for the rest of its time ashore.

With the exception of *Pelecanoides*, I have noticed that parent petrels, within my experience, seldom attend the chick together, and the Sooty Shearwater from my limited records taken in 1942-43 seems to follow the same behavior. Of 26 visits paid to burrows at night after the chick was hatched on 14 occasions no bird was present, on 10, a single bird was found, while on two occasions both parents were with the chick. In one case the chick was attended by an adult all day, but in the second case the chick had been alone for that time.

In 1943-44 with 59 chicks under observation (see table 1) on the island until February 12, I searched for parents far more diligently and only on one occasion did I discover two adults with a chick. This corroborates very strongly the deductions of the previous year. To illustrate still further this absence of birds from breeding burrows, on February 5, 1944, I investigated after dark 42 burrows harboring chicks and found not a single parent. At an additional 18 burrows without chicks only one bird was present.

FEEDING AND RELATED TOPICS

Table 4 presents feeding data based on eight chicks studied in the season of 1941-42 when I was on the island from December 20 to March 14. Each chick was weighed twice daily, the quantity of food received each night being determined by the difference in weight between the evening and the following morning. Nights on which chicks were not fed are also noted. Weights indicated by an asterisk represent the amount of food

Table 4

Nights fed and amount of food in grams given to eight chicks in 1942

Nest	Hatched	January											February					
		21	22	23	24	25	26	27	28	29	30	31	1×	2	3	4	5	6
1	Jan. 19	31	29	21	25	nf	nf	78	88	56	3	35	nf	nf	nf	nf	nf	90
2	Jan. 19	nf	nf	nf	nf	55	4* 20	5	6	28	nf	nf	60	68	42	31	nf	nf
3	Jan. 26						2* —	7* 6	−2	19	41	32	54	13	53	54	24	30
4	Jan. 20	3* 7	0	33	23	47	nf	nf	nf	nf	nf	63	77	32	35	26	69	nf
5	Jan. 20	11	3	23	nf	nf	nf	53	44	44	19	53	nf	nf	nf	nf	92	85
6	Jan. 20	18* nf	2	41	22	63	61	8	73	23	nf	nf	nf	nf	nf	184	202	118
7	Jan. 19								76	nf	nf	nf	nf	nf	nf	nf	nf	116
8	Jan. 25													nf	nf	nf	114	nf

	February																
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	170	85	nf	nf	nf	nf	nf	nf	nf	nf	nf	75	110	nf	180	150	60
2	nf	nf	nf	121	63	nf	nf	110	nf	nf	nf	115	63	nf	nf	15	nf
3	nf	67	nf	53	nf	nf	nf	134	59	99	70	50	nf	nf	187	85	85
4	nf	155	104	nf	38	50	nf	nf	nf	nf	nf	nf	nf	160	75	70	50
5	nf	120	nf	nf	nf	nf	nf	nf	nf	nf	nf	132	180	120	nf	120	110
6	63	60	nf	nf	nf	nf	nf	nf	nf	224	125	115	100	45	80	55	nf
7	82	110	nf	207	nf	55	nf	nf	nf	nf	nf	nf	nf	nf	205	30	300
8	90	70	145	95	10	nf	nf	nf	nf	nf	nf	95	205	−5	nf	120	90

	February					March										
	24	25	26	27	28	1	2	3×	4	5	6	7	8	9	10	11
1	nf	nf	nf	nf	nf	nf	nf	nf	90	50	135	nf	240	nf	145	35
2	nf	205	20	nf	50	nf	nf	nf	nf	nf	260	40	nf	nf	nf	nf
3	nf	nf	nf	nf	nf	nf	nf	165	150	75	nf	75	35	100	35	nf
4	nf	nf	nf	100	80	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	145
5	100	nf	nf	nf	nf	nf	nf	nf	nf	nf	245	60	185	55	nf	nf
6	nf	nf	nf	nf	175	nf	25	225	50	50	85	nf	nf	nf	nf	nf
7	nf	120	75	nf	nf	nf	nf	nf	100	85	35	100	30	105	nf	nf
8	nf	210	nf	nf	nf	110	125	nf	nf	nf	nf	nf	nf	170	70	70

Key: *, food given to a chick during the day by a guarding parent; ×, means full moon; nf, means not fed during night. A minus sign prefixed by a figure indicates that though the chick was fed, the morning weight was less than the previous evening weight.

given by a guarding parent during the day, and this occurred several times the first few days. The amount of food as shown by the table varies from 0 to 300 grams, but it must be remembered that these weights, owing to the methods used, will be slightly less than the actual weights.

The data for table 5 were compiled from figures given in table 4, and also from three additional chicks which died early. It will be observed that 70.3 per cent of the

Table 5

Weights of 192 meals given to 11 Sooty Shearwater chicks in 1941-42, grouped into class intervals of 20 grams

Class interval in grams	Number of meals	Percentage	
0 to 19.9	27	14.1	
20 to 39.9	33	17.2	
40 to 59.9	29	15.1	70.3
60 to 79.9	28	14.7	
80 to 99.9	18	9.4	
100 to 119.9	18	9.4	
120 to 139.9	11	5.7	
140 to 159.9	6	3.1	23.4
160 to 179.9	5	2.6	
180 to 199.9	5	2.6	
200 to 219.9	6	3.1	
220 to 239.9	2	1.0	
240 to 259.9	2	1.0	6.3
260 to 279.9	1	0.5	
280 to 299.9	0	0.0	
300 to 319.9	1	0.5	

meals received weighed less than 100 grams, that 23.4 per cent were under 200 grams, and that 6.3 per cent exceeded 200 grams. The heaviest meal was one of 300 grams, the next heaviest, 260 grams. After the sixth class interval there is a rapid reduction in the number of meals in each group as the weights per meal increased. In addition to the 192 nights noted in the foregoing table, when meals were given, there were 215 other nights when the 11 chicks remained unfed, representing 52.8 per cent of the total nights they were being weighed. The individual range in number of nights when chicks were not fed varied from 35.6 to 60.5 per cent.

Table 6

A comparison of five species of petrels as to number of nights nestling chicks remain unfed

Species	Number of cases	Average percentage of nights unfed	Range	References to papers (Richdale)
Pachyptila turtur	17	22.75	12.5 to 47.6	1944c:45-46
P. vittata (= *forsteri*)	12	34.8	12.5 to 56.3	1944a:194-195
Pelagodroma marina maoriana	16	31.3	16.4 to 59.0	1943b:220-221
Pelecanoides urinatrix	11	2.75	0.0 to 10.5	Unpublished
Puffinus griseus	11	52.8	35.6 to 60.5	Present study

In table 6 I have grouped data relative to the irregularity of the feeding process in all the petrels I have studied on Whero. Those for *Pachyptila turtur* and *Pelagodroma* are complete from hatching to departure. At the time I studied *Pelecanoides* I was not with this species for its whole shore period and my work was confined to a series of older and younger chicks. I have shown (1943a:98) that from a grand total of 370 pairs of daily weights of 14 chicks, there were only 10 occasions, excluding the two or three when a chick remained too long after it was due to leave, when a chick was not fed. The figure 10.5 per cent given in table 6 is based on a chick weighed only during its last 19 days ashore when it was fed on every night except the last two. This in all probability raised the percentage beyond the true level. Thus, it was only rarely that a

chick of *Pelecanoides* was not fed. Only one chick was weighed for its full time of 48 nights in the burrow, and on only three of them was it not fed.

In regard to *Pachyptila vittata*, the range of records obtained for 12 chicks from their last 15 to 26 days in the burrow (average of 18.7 days) was taken at the end of 1942 when I was on the island during the latter part of the season. A tendency for the occurrence of a short fasting period at the end may cause the average given in the table to be a little higher than it should be.

The average of 52.8 for the Sooty Shearwater, which is much higher than that for any of the other petrels, was taken during the chicks' first 52 days ashore with probably more than 40 days to follow before departure from the nest. If, as is alleged, there is a long starvation period at the end, this percentage would rise still higher.

Table 7

Data relative to the irregularity of the feeding process in the Sooty Shearwater

		Nights when not fed			Quantity of food received			
Nest	Days in burrow	Number of times not fed	Number of days weighed	Percentage of days not fed	Number of nights when fed	Amount received in grams	Average in grams for each night fed	Average per day in grams
1	52	27	50	54	23	1981	86.13	39.62
2	52	30	50	60	20	1381	69.05	27.62
3	45	16	45	35.6	29	1857	64.03	41.27
4	51	28	50	56	22	1442	65.55	28.84
5	51	29	50	58	21	1854	88.28	37.08
6	51	23	50	46	27	2292	84.88	45.84
7	52	26	43	60.5	17	1831	108.29	42.58
8	46	21	38	55.3	17	1784	104.94	46.97

The foregoing table deals with eight chicks, watched in the season of 1941-42 from date of hatching toward the end of January to the middle of March. It will be noted that chick 7 was not fed on the greatest percentage of nights. In spite of this, the average amount of food it received per meal was greater than that for any of the other chicks, being 108.29 grams. On the 50th day it attained its greatest morning weight of 940 grams. When the average per day, including all days weighed, is taken, the weight is not the greatest, being only 42.58 grams.

In contrast to the above is the chick at nest 2 which was not fed for 60 per cent of nights when it was weighed. It received the lowest aggregate amount of food (1381 grams), with a daily average of only 27.62 grams. When the average amount per meal is computed it proves to be a comparatively high figure (69.05 grams). This chick, however, must have been unhealthy, for all records indicated that growth was retarded. Recalling table 2, where certain age characteristics of normal chicks are given, with chick 2 the mesoptyle appeared on the scapulars on the 10th day, on the forearm three days later, and on the hand on the 21st day; the egg tooth did not disappear till the 40th day; at the time of last inspection on its 52nd day the chick showed no sign of scapular feathers. In normal chicks of this age, tail quills are emerging.

Chick 3, for which the percentage of nights unfed is lowest, did not receive, as might be expected, a large total amount of food; as a matter of fact, the actual average per meal (64.03 grams) was the lowest of all the chicks. Thus, there seems to be a tendency, as is the case with *Pelagodroma* (Richdale, 1943b:220), for chicks which remain unfed to make up the deficiency when the parents do arrive. There is a further

tendency, too, for the average amount of food received per night ashore to level up when the amount of food received is divided by the total number of weighings including the nights unfed, as shown in table 7.

Table 8

Length and number of spans in days between feedings of eight chicks

Chick	Days										
	1	2	3	4	5	6	7	8	9	10	Total
1	3	1			1			1	1		7
2	1	4	1	2	2						10
3	4	1	1				1				7
4	1	1	1		1		1			1	6
5	2	1	1	1					2		7
6	1				3		1				5
7	3	1			1			2			7
8	3		2			2					7
Total	18	9	6	3	8	2	3	3	3	1	56

Table 8 presents data on the length and number of spans when the chicks were not fed. It must be remembered that I did not handle the parents of these chicks so that my activities could not have influenced the above results. Chick 4, from the 41st to the 50th day inclusive, a period of ten days, remained unfed. The weight of this bird dropped from 660 grams to 425 grams at 9 p.m. on the eleventh night, the last night I weighed the birds, when it received 145 grams of food. Prior to this it had experienced two fasts of five and seven days, respectively.

Chick 5 fasted for two periods of nine days each. The first occurred between the 21st and 29th days, when the weight dropped from 360 to 196 grams; the second occurred between the 37th and 45th days, when the weight dropped from 760 to 485 grams. The first fast was followed by meals of 132, 180, and 120 grams, respectively, which were quite substantial. The second was succeeded by amounts of 245, 60, 185, and 55 grams before a subsequent fast.

Chick 9 was fed during the first five days of its life. Then for the next eight nights it received nothing and eventually succumbed. After dark, on the tenth night, that is, its fifth night without food, hearing it squeak I found it at the entrance of its burrow vainly waiting for the arrival of its parents. On the 13th day it was almost paralyzed, though still able to emit a faint squeak; in that fast period it dropped from 141 to 68 grams.

Chick 2 nearly met its death due to a lengthy early fast. At 9 p.m. on the day after hatching it weighed 96 grams. Four nights later at 9 o'clock, having received no food in that time, it had dropped to 61 grams. Naturally it was very weak, squeaking very little and not fighting at all. On the following day at 9 a.m. it weighed 116 grams; thus, it must have received its own weight in food! Its vigor was quickly restored, too, for it made many attempts to bite me. On the following morning its weight had risen to 126 grams. A parent remained with it all that day. At 9 p.m. its weight was 130 grams; apparently it had been fed during the day. This occurred on the eighth day, a time when it is unusual for parents to be with chicks. The longest fasts this chick experienced were two of five days. It was the "runt" of the colony, as already explained, and possibly the severe early fast was responsible for its poor health.

Other chicks appeared to die because neither parent appeared with food. Chick 11 was found dead on February 1, after a fast. On the following night an adult was in the

burrow, and on the night of February 2-3, there was a second bird. Of course, I do not know for certain whether or not they were parents of chick 11. They may have been wandering, non-nesting birds, but these were not numerous at this date. Chicks of the Manx Shearwater are also known to undergo fasts before the parents desert them finally (Lockley, 1942:85).

With respect to irregular feeding, it is of interest to note the important discoveries of Lockley (1935:105-107; 1942:126) regarding the feeding grounds of Manx Shearwaters under his observation. In May and June, 1939, he obtained six ringing returns which showed that some of his birds were feeding in the Bay of Biscay, 600 miles away from where they had nests and eggs at Skokholm, an island off the coast of Wales. When one compares the long absences of Sooty Shearwaters from their nests during the incubation and nestling periods with Lockley's findings, it seems likely that the birds breeding on Whero feed at a considerable distance from their nesting area. Irregular feeding of nestlings, although not with such long periods between feedings, also occurs in some species of storm petrels (Richdale, 1943b:222-223).

In an attempt to discover if weather conditions have any relation to the number of chicks fed on any one night I made a survey covering eight chicks on the last 38 nights of my stay on the island. No chicks were fed on one night only; a single chick was fed on four nights; two chicks were fed on eight nights, three on seven, four on ten, five on four, six on two, seven on one, and eight on one night. The average number of chicks fed per night was 3.4. On the night of February 21-22, when all eight chicks were fed, it had been rough all day with an east wind. Throughout the day, more birds than usual were off-shore, and they were particularly plentiful toward evening. On February 12-13, a calm, dark night, not one chick was fed. The day of February 7 was sunny with a very strong southwest wind, which died down in the evening; that night no less than seven of the eight chicks were fed. From this survey it appears that weather has little influence on occurrence of feeding, for the number of chicks fed fluctuated considerably, even when weather conditions were much the same over Whero. If, as suggested, parents feed several hundred miles from their breeding grounds, it may be that weather over distant areas may be a determining factor.

Table 9

Average weight and number of meals given to eight chicks during successive four-day periods

Class interval in days	Number of meals	Average weight in grams	Class interval in days	Number of meals	Average weight in grams
1- 4	22	13	29-32	16	126
5- 8	22	38	33-36	17	103
9-12	22	44	37-40	10	111
13-16	13	62	41-44	9	149
17-20	17	107	45-48	17	101
21-24	13	86	49-52	7	108
25-28	7	105			

To construct table 9 the nightly meals were put down in columns according to the age of the eight chicks under study. Thus, the first column recorded the weight in grams of the food received by each chick on the first day after the hatching; the second column the amount received by each on the next, and so on. The columns were then grouped into sets of four each, the totals of each set found and divided by the number of feedings which occurred.

Table 10

Average weights of meals given to eight chicks at various periods

Occasions when weights taken	Number of cases	Average in grams
Following 1 or 2 nights without food	25	100.5
" 3 or 4 " " "	9	103.1
" 5 or 6 " " "	9	139.8
" 7 or 8 " " "	5	168.8
" 9 or 10 " " "	3	149.3
1st meal after a fast	50	122.9
2nd " " " "	37	91.5
3rd " " " "	26	89.1
4th " " " "	14	51
5th " " " "	10	42.2
6th " " " "	3	84.6
7th " " " "	1	55

Table 10 was prepared to determine whether or not the average weights of food given are influenced by periods of fast and by successive meals. Owing to the large percentage of nights when chicks remained unfed, the number of cases is somewhat low. The results would seem to indicate, however, that meals after a fast increase in size in proportion to the length of that fast. With respect to successive meals after a fast, the first is most decidedly the heaviest and thereafter, as they succeed one another, there is a tendency for the meals to become lighter. The number of cases given also indicate quite clearly that chicks of the Sooty Shearwater are not fed very many nights in succession before there is a fast. Of 55 when chicks were fed on consecutive days (table 4), 69 per cent of these periods did not exceed 3 days and 91 per cent were less than 6 days. The average was 3.15 days and the range from 1 to 12 days. One chick was fed on each of 12 days following hatching. The next longest periods were one of 8 days, one of 7, and two of 6 days each.

In concluding this section I should like to mention the "starvation period" through which chicks of petrels are supposed to pass at the end of their life as fledglings. My researches with the Yellow-eyed Penguin (*Megadyptes antipodes*) and five species of petrels, *Diomedea, Pelecanoides, Pelagodroma, Pachyptila turtur,* and *P. vittata,* indicate that it is practically non-existent and that in every species mentioned some of the chicks were fed the night before they left the nest. Under these circumstances I feel that I am justified in being sceptical about the "starvation period" of the Sooty Shearwater. As yet, too small a number of chicks has been studied to settle this point, According to Cockayne (1909:38), "about the middle of April the old bird ceases to feed the young one, which, gradually losing its excessive fat in consequence, becomes vigorous, . . ." In a footnote on the same page this writer expresses doubt regarding the reliability of his informant's insistence that all mutton-birds lay on November 25. Such an informant is not likely to be any more accurate about events in the middle of April. In an earlier paper (Richdale, 1942:171, 172, 261) I have shown how fat chicks of *Pelecanoides* lose weight at the same time that they are still being fed. The same appears to be true of *Pelagodroma* and the two species of *Pachyptila,* and possibly of *Puffinus,* also.

It has already been shown that during its first 52 days in the burrow a chick of the Sooty Shearwater may fast over several long periods of as many as 10 days. Possibly one such fast precedes the time of departure of the chick from its burrow. In the Manx Shearwater, according to Lockley (1930:204-214; 1931:204; 1942:85), a short fast

does occur prior to departure from the burrow. If this is true of the Sooty Shearwater, then there would appear to be a moderate starvation period, but it is not as long as we have been led to believe. I have already given evidence of reduction in weight during a fast, but the whole of the loss of weight prior to first flight does not occur during the final fast in the burrow.

WEIGHTS AND MEASUREMENTS OF THE GROWING CHICK

In table 11 below are given weights, at 9 a.m. and 9 p.m., of eight chicks of the Sooty Shearwater during the first 52 days of their life in the burrow. In working out the data for the table all the weights concerned were put down in columns representing the age of the chick, so that each column contained 16 weights, two for each day. The eight morning and the eight evening weights were then totalled and averaged separately, and so on for each day. The averages were then divided up into class intervals of four days and the average of these four averages was taken. In this way the daily fluctuations caused by extra heavy or extra light meals were smoothed out. Owing to the considerable frequency of non-feeding on many nights and to the irregular amounts of food transferred on other nights, a daily graph reveals many peaks and hollows.

It will be noticed from the table that except for a drop at the age of 41 to 44 days, the weights continued to increase to the end of the period of study, indicating that a general plateau had not yet been reached. A plateau is not to be expected since feathers have only begun to grow.

Table 11

Weights in grams of eight chicks of the Sooty Shearwater during their first 52 days ashore

Class interval in days	9 a.m.	9 p.m.	Difference
1- 4	93.77	90.38	3.39
5- 8	141.4	132.62	8.78
9-12	201.52	188.94	12.58
13-16	225.15	211.62	14.53
17-20	308.81	288.78	20.03
21-24	390.31	373.53	16.78
25-28	389.87	387.18	11.69
29-32	501.84	482.65	19.19
33-36	616.75	593.75	23.00
37-40	667.97	646.25	21.72
41-44	629.53	612.09	17.44
45-48	717.88	698.63	19.25
49-52	762.81	740.10	22.71

Graphs of the daily weights of all eight chicks were made. In all cases during the 52 days that records were taken, the lowest point of a depression reached after a fast was nearly always higher in succeeding fasts. This is amply shown in the two records in figure 10, which represent chick 6, which attained the heaviest weight, and chick 2, which, as explained before, appeared to be subnormal and weighed less than all other chicks. Neither of these graphs shows very long fast periods. Chick 1 suffered two periods of nine and eight days, chick 5 two periods of nine days each, and chick 4 seven- and ten-day periods, which make the depression sweeps much more spectacular (see table 8).

In the graph (fig. 10) showing meals and fasts of chick 6, there are only five periods of fasting and five of feeding. With all other chicks, the number of fastings and feedings was greater; chick 2 (fig. 10) had the most, a total of 20, that is, its alternate meal

and fast periods were shorter than those of any other chick. For the first nine days chick 6 received, on consecutive days, a total of 311 grams of food followed by a five-day fast; in the next five days it received 627 grams followed by a seven-day fast, then 744 grams in seven days followed by a five-day fast, and a single meal of 175 grams followed by a single-day fast. Lastly, a five-day period when 435 grams were delivered ended with a five-day fast corresponding to my last five days on the island. Chick 2

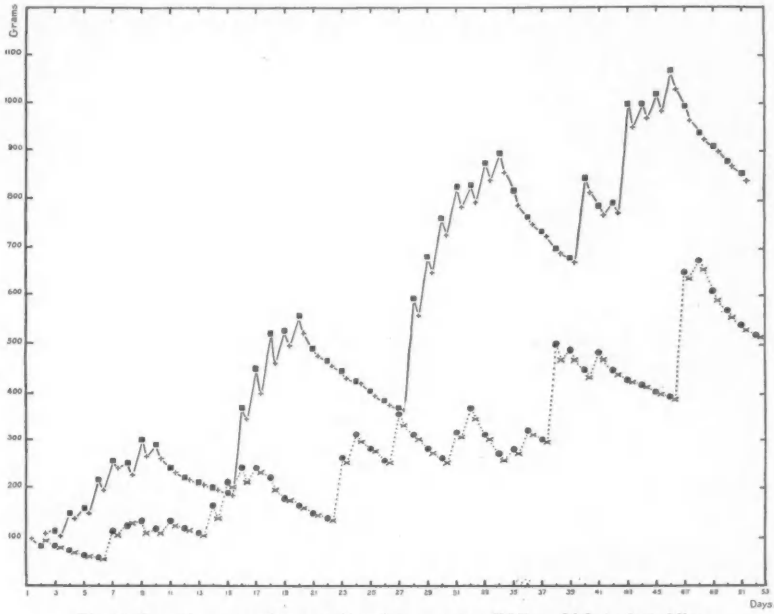

Fig. 10. Growth curves of two nestling shearwaters; solid line, chick 6; dotted line, chick 2. Solid symbols indicate weights at 9 a.m.; crosses, weights at 9 p.m.

had more meal periods interspersed with shorter fasts—much shorter than those of other chicks. The growth of chick 6 was relatively slow until the 47th day when its weight increased after a five-day fast from 390 to 650 grams. This may have been the turning point in its life, but unfortunately soon after this I left the island. Thus, the fate of this nestling was not determined; perhaps it was a *kihaka*.

Some points of interest about the weights and weight increases may be noted. Of the eight chicks which were weighed daily, the one at nest 6 attained the heaviest weight of 1070 grams on its 47th day; the lowest peak-weight attained by any chick was that of chick 4 which reached 660 grams on the 40th day. The greatest weight of chick 2, the *kihaka*, was 675 grams on the 48th day. On the 37th day chick 8 reached its heaviest weight, 910 grams; chick 6 was next heaviest, weighing 760 grams. Chick 2 weighed only 300 grams and was easily the weakest.

The largest increase in weight in any one night was that of chick 7 on its 36th day when it advanced from 550 to 850 grams, an increase of 300 grams. On the 25th day at 9 p.m. this chick weighed 540 grams and was not fed for the eight following nights;

thus, at 9 p.m. on the 33rd day, it weighed 365 grams, having dropped 175 grams. During the next three nights it received 205, 30, and 300 grams, respectively, rising to 850 grams, an increase of 133 per cent at 9 a.m. on the 36th day. It will be seen that a 365-gram chick received 535 grams of food in three nights.

The results of an earlier eight-day fast by this chick are also worth noting. On the tenth day at 9 p.m. it weighed 285 grams. After the fast it weighed 161 grams at 9 p.m., having dropped 124. In the succeeding three nights it received 116, 82, and 110 grams, respectively, and finally weighed 425 grams, a total increase of 164 per cent. Thus, in three nights this 161-gram chick received 308 grams of food.

Chick 5 had a similar experience. On its 20th day at 9 p.m. it weighed 336 grams, after which it was not fed for nine days and weighed 196 grams at 9 p.m., having dropped 140 grams. During the next three nights it received 132, 180, and 120 grams, respectively, rising to 590 grams or 120 per cent; this chick received 432 grams of food in three nights. During a second fast period of nine nights it dropped from 720 grams on the 36th day to 485 grams on the 45th day, a drop of 235 grams. In the three succeeding days it received 245, 60, and 185 grams, respectively, rising to 935 grams, an increase of 93 per cent. Thus, in three nights it received 490 grams of food.

A final example is that of chick 6 which advanced on its 17th day from 187 to 371, that is, its weight was almost doubled after a five-day fast. During the next two nights it received 202 and 118 grams, respectively, receiving in all 504 grams and advancing to 520 grams at 9 a.m. on the 19th day. The increase in three days was 125 per cent.

In summary, it is apparent that owing to the irregularity and relative infrequency of feeding, the weights of nesting Sooty Shearwaters fluctuate considerably. Further, it is evident that weight at any particular time is not a satisfactory index to the age of a chick, for on a succeeding day it may be almost double, or in three days treble, its previous weight.

Weekly average measurements and weights of eight chicks, from day of hatching to their 50th day ashore, are summarized in table 12.

Table 12

Average weekly measurements and weights of eight chicks

Feature	1st	8th	15th	22nd	29th	36th	43rd	50th day	
Bill	19.27	21.07	22.72	25.31	27.96	31.06	33.43	35.17	mm.
Nostril to tip	12.11	13.47	15.22	17.20	19.12	21.43	23.37	24.66	
Wing	26.41	30.10	34.50	45.50	55.50	72.87	92.50	115.00	
Toe and claw	24.5	27.57	31.70	36.62	43.53	50.06	55.70	58.04	
Claw	4.61	5.00	5.65	6.10	7.28	7.84	8.37	8.73	
Weight	75	155	223	362	446	666	634	738	grams

It has already been shown that chick 2 was a retarded individual and possibly a *kihaka*. Its weekly weights and measurements are included in the averages in the above table. Those for its 50th day, given for comparative purposes, are as follows: bill, 29 mm.; nostril to tip, 19; wing, 62; toe and claw, 46; claw, 7; and weight 570 grams.

Additional data on size and weight of chicks are given in table 13, which is based on 8 chicks on the island of Whero, May 11-13, 1941, plus 22 and 5 chicks from Herekopare, studied in the periods May 15-17, 1942, and May 7-8, 1943, respectively. All were caught on the surface at night; some had a considerable amount of down on

belly and breast, while 10 were entirely free of down. Three others, definitely *kihakas*, are not included in the table.

Table 13

Measurements and weights of 35 chicks of the Sooty Shearwater taken in May

Feature	Mean	σ	Probable error of mean	Range
Bill length	41.74 mm.	1.67	.18	39- 44¼
Wing	295.75	10.17	1.13	276-315
Toe and claw	68.4	1.97	.22	65- 71
Claw	11.27	.58	.06	9- 12¼
Weight	659 grams	128.4	14.3	430-970

Table 14 has been prepared from data given in table 13 dealing with 35 chicks and from other data in my earlier paper (Richdale, 1944b:106). The purpose of this table is to show to what extent, if any, the chicks continue to grow after leaving the nesting area. It should be noted, however, that exact dates of departure of the chicks from the island were not known. The only measurement likely to be affected seriously by this lack would be length of wing, which, according to my measurements on other petrels, continues to grow until time of departure. Presumably this is true of the Sooty Shearwater, also. Hence, the wing measurements would tend to be somewhat shorter than at the time of departure. Weights, on the other hand, would, if a starvation period is in force, tend to be somewhat greater.

Table 14

A comparison of size and weight of 100 adults and 35 chicks of the Sooty Shearwater

Feature	Difference	Probable error of difference	Type of bird with longer measurement
Bill length	.12 mm.	.21	adult
Wing	8.25	1.22	adult
Toe and claw	.85	.27	chick
Claw	.61	.07	chick
Weight	128.00 gms.	14.92	adult

Before recognizing a difference between means as significant, I have ruled that it must be at least four times the value of the probable error of the difference. Applying this rule, the differences in bill length and in toe with claw are not significant; the difference in wing length probably is significant even when allowance is made for additional growth prior to departure, as discussed above. The difference in weights, provided the sample of chicks is not too small, is decidedly significant. It will be noted that the claw of the chick is significantly longer than that of the adult; this is to be expected, as the claw of the chick is worn very little.

LITERATURE CITED

Ainslie, J. A., and Atkinson, R.
1937. On the breeding habits of Leach's fork-tailed petrel. Brit. Birds, 30:234-248, 276-277.
Archey, G., and Lindsay, C.
1924. Notes on the birds of the Chatham Islands. Rec. Canterbury Mus., 2:187-201.
Bent, A. C.
1922. Life histories of North American petrels and pelicans and their allies. U. S. Nat. Mus., Bull. 121 : xii + 343 pp.
Buller, W. L.
1888. A history of the birds of New Zealand (London, J. Van Voorst), 2nd ed., 1:1-250; 2:1-340.

Cockayne, L.
1909. Remarks on the bird life. Report on a botanical survey of Stewart Island. Dept. Lands N. Z., C-12, pt. 5:1-68.

Falla, R. A.
1934. The distribution and breeding habits of petrels in northern New Zealand. Rec. Auck. Inst. Mus., 1:245-260.

Gross, W. A. O.
1935. The life history cycle of Leach's petrel (*Oceanodroma leucorhoa leucorhoa*) on the outer sea islands of the Bay of Fundy. Auk, 52:382-399.

Hadden, F. C.
1941. Midway Islands. Hawaiian Planters' Record, 45:179-221.

Lockley, R. M.
1930. On the breeding-habits of the Manx shearwater, with special reference to its incubation- and fledging-periods. Brit. Birds, 23:202-218.
1931. Further notes on the breeding-habits of the Manx shearwater. Brit. Birds, 24:202-207.
1932. On the breeding-habits of the storm-petrel with special reference to its incubation and fledging-periods. Brit. Birds, 25:206-211.
1935. Movements of Manx shearwaters. Brit. Birds, 29:105-107.
1942. Shearwaters (London, J. M. Dent and Sons), xi + 238 pp.

M[arples]., B. J.
1941. Sooty Shearwater (*Puffinus griseus*). Second Ann. Rept. Ornith. Soc. New Zealand (mimeographed), page 6.

Oliver, W. R. B.
1930. New Zealand birds (Wellington, Fine Arts, Ltd.), viii + 541 pp., 6 colored pls., many ills.

Richdale, L. E.
1939. A royal albatross nesting on the Otago Peninsula, New Zealand. Emu, 38:467-488.
1942. Supplementary notes on the royal albatross. Emu, 41:169-184, 253-264.
1943*a*. Kuaka or diving petrel, *Pelecanoides urinatrix* (Gmelin). Emu, 43:24-48, 97-107.
1943*b*. The white-faced storm petrel or Takahi-kare-moana, *Pelagodroma marina maoriana* (Mathews). Trans. Roy. Soc. N. Z., 73:97-115, 217-232, 335-350.
1944*a*. The parara or broad-billed prion, *Pachyptila vittata* (Gmelin). Emu, 43:191-217.
1944*b*. The sooty shearwater in New Zealand. Condor, 46:93-107.
1944*c*. The titi wainui or fairy prion, *Pachyptila turtur* (Kuhl). Trans. Roy. Soc. N. Z., 74:32-48, 165-181.

Roberts, B.
1940. The life cycle of Wilson's petrel, *Oceanites oceanicus* (Kuhl). Brit. Graham Land Exped., 1934-37, Sci. Rept., 1, no. 2:141-232.

Department of Zoology, University of Otago, Dunedin, New Zealand, December 7, 1944.

MOLT IN FLIGHT FEATHERS OF FLICKERS

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Molt in flickers has been described by Stone (1896:112-115, 117, 128, 130) and, in part, by Friedmann (1930), but my findings are contradictory to some of those of the former investigator and provide certain additional information. The data given below were gathered in the course of examination of about 1250 study skins, 150 living birds (some held in captivity for several months), and a small number of alcoholics. The principal objective of this examination was a study of coloration, and no record was kept of the number of molting birds, which is now estimated to be about one-tenth of the above figures. It was felt at the time of the original study that enough birds had been examined to make well-founded the conclusions reached. Subsequent work with an additional 1200 specimens has shown this belief to be correct.

The majority of birds seen belong to the species *Colaptes cafer*, but *C. auratus*, *C. chrysocaulosus*, *C. chrysoides*, and *C. mexicanoides* are also represented by sufficient numbers to indicate any striking differences.

In this paper the customary method of numbering the flight feathers is followed. The sequence of primaries is from proximal to distal ends of the manus, whereas the most distal secondary is number one, and number twelve is nearest the body. Burt, in his study of woodpecker pterylography (1929:439), records only eleven secondaries, but there are definitely twelve. Rectrices are numbered from the central pair outward on each side.

TIME AND SEQUENCE OF MOLT

Newly hatched flickers are without down, and it is some time before the papillae of the juvenal plumage appear above the surface of the skin. All appear at about the same time, and their rates of growth remain fairly equal, at least within the same type of feather. This being true, the shorter feathers, as the inner secondaries, inner primaries, and primary ten, attain their full lengths before the longer feathers do. Juvenal primaries one and two are considerably weaker than the other primaries. Number two is only about two-thirds the size of primary three, which is about 85 mm. long, and number one is even smaller. This contrasts with the condition in adult plumage, in which primaries one and two are approximately as strong as number three and only a few millimeters shorter (about 15 mm. and 10 mm., respectively).

The time of inception of the postjuvenal molt varies considerably in different individuals, probably in the main because of differences in time of nesting of different pairs of adults. The first feathers molted apparently are lost about the time the bird leaves the nest (as found in European woodpeckers by the Heinroths [1931, vol. 4]) and at least sometimes (perhaps always) before the longest juvenal remiges and rectrices are mature. This date of first loss of feathers may be, in different individuals, from the early part of June to the last of July in *auratus* and *cafer*, in March or April in *chrysocaulosus*, from May to July in *mexicanoides*, and in May in *chrysoides*.

The first feathers lost are the weak primaries, one and two, in that order, but not far apart in time. After a somewhat longer interval, number three is dropped, then number four, and so on consecutively, through ten. I have not recorded the molt in number eleven; it probably follows primary ten. As in most species of birds, molt and subsequent regeneration are approximately symmetrical on the two sides of the body in primaries, secondaries, and rectrices. One of a pair of feathers may, however, be a

few millimeters ahead of the other in growth, and sometimes the disparity is even greater. I have seen instances in which an adult primary was half-grown, while the corresponding feather in the other wing was an unmolted juvenal.

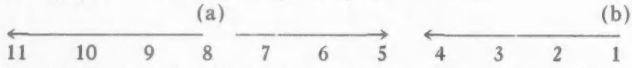
Usually, no postjuvenal molt takes place in the series of secondaries, the juvenal feathers being retained until the first annual molt late in the following summer. This is directly contradictory to statements in the literature regarding molt in woodpeckers in general (Stone, 1896; Dwight, 1907; Heinroth and Heinroth, 1931) and in flickers in particular (Palmer, 1901; Bent, 1939). These authors state that a complete postjuvenal molt occurs. Possibly some of the above authors who did original work on the problem were misled by finding growing secondaries present simultaneously with the growth of the inner adult primaries. This is a result of the short time that juvenal primaries one and two are held before their early loss, as noted above. My work has uncovered no evidence for anything approaching a complete loss of secondaries in the postjuvenal molt of flickers. Infrequently, however, a few of the proximal secondaries are molted. This was watched in a captive *auratus*, in which secondaries ten and eleven in one wing and nine, ten, and eleven in the other wing were molted and replaced in the order given. The same thing is indicated by several study skins in which a few proximal secondaries have a more intense carotenoid color (red or yellow) than does the rest of the series. A pale carotenoid color is characteristic of juvenal plumage. Another point of importance is shown by the same captive *auratus*: where molt is irregular in occurrence it is frequently not symmetrical on the two sides.

Molt of the rectrices usually begins when that of the primaries is about half completed. The small rectrix six is usually shed first, but its loss is somewhat irregular in time, and apparently it may be shed in almost any sequence with regard to the others, even to being the last one lost. In the large rectrices, however, the sequence appears to be invariable; it is, as noted by Stone (1896), Friedmann (1930), and others: 2, 3, 4, 5, 1. Numbers two, three, and four are apparently shed and regenerated in that order in rapid succession, especially two and three. Five follows at about the time two, three, and four are one-fourth or one-third grown. Number one follows number five at a similar time interval.

The whole postjuvenal growth of flight feathers is usually completed in September or October, primary ten (eleven?) or rectrix one being the last to reach maturity.

The annual molt of adults does not differ greatly from the postjuvenal molt except that the secondaries are always involved. In *auratus* and *cafer* the molt apparently begins about the middle of June with the loss of primary one. The other primaries follow consecutively, two to ten (eleven?) at rather long intervals. An irregularity was found in one specimen of *cafer*, in which number one was regenerated late, with number seven.

Molt of the secondaries begins about the time primary three is shed. It is somewhat irregular in extent and in exact sequence, but the order is usually: 8, 9, 7, 6 or 10, 1 or 2, 3 or 11, 5, 4. Diagramed, it may be represented thus:



Here, molt and replacement are initiated in secondary eight and proceed both distally and proximally at the same time. Soon after secondaries six and ten have been lost, number one (usually) is molted, from which point molt and regeneration move proximally. It appears that the molt wave initiated in secondary eight never proceeds distally beyond number five, and molt started in secondary one never gets beyond four.

This molt of the secondaries is different from that recorded by Stone (1896:113), apparently for birds in general, but is of the convergent type, as stated by Heinroth (1898). It is similar to that of the Loggerhead Shrike (Miller, 1928) in the presence and location of the two molt centers, but differs slightly in the point at which the molt waves from these centers meet. A greater difference occurs in the sequence of feather loss as a result of the late origin in flickers of the wave beginning in secondary one.

As Miller (1928:415) has suggested for shrikes, there is probably a significant relation between the presence of a distal and a proximal molt center in the secondaries and the double embryonic origin of the series of secondaries as revealed by Steiner (1918). Steiner found that the first four secondaries are derived from papillae originally in series with papillae which produce greater undercoverts in the region proximal to secondary four. As embryonic development proceeds, the distal end of this longitudinal row of feather fundaments migrates to the posterior edge of the wing, thus coming in line with the feather germs of proximal secondaries, which develop in their original positions. It is not strange, therefore, that these two groups of secondaries should have separate centers in which molt is initiated. Likewise, it is not surprising that the approaching molt waves from these centers should not proceed beyond the interval between feathers four and five, which is the site of union of the two ontogenetic groups of secondaries.

In the light of this knowledge it is indeed interesting that the four distal secondaries are so like the rest of the secondary series in form and pigmentation. These two characteristics would appear, in the light of Steiner's work, to be dependent upon position on the wing and induced by surrounding influences. In contrast, the factors controlling place of initiation and extent of molt waves (perhaps those postulated by Miller [1941: 115]) seem to be inherent in the feather papillae—determined before their migration to the posterior edge of the wing. Skin-grafting experiments by Danforth (1929) indicate that in the chicken the form and coloration of feathers is fixed (except for sexual differences) by time of hatching.

In a considerable proportion of birds the molt waves from secondaries eight and one do not meet, leaving one or more feathers to be retained an additional period. This phenomenon is indicated by the presence in many birds taken in late fall, in winter, and in spring, of a fourth secondary that shows a much greater degree of wear and a more faded carotenoid color than does the rest of the series. Secondary three is almost as frequently retained and secondary two only a little less often. Numbers one and five also are sometimes found to be those of the year before.

There is excellent evidence for believing that the unshed secondaries in the region of number four frequently are not kept for an entire additional year. Instead, they may be lost and regenerated at some time between annual molts. Differences in degree of abrasion and fading and differences in size, as discussed below, form part of this evidence. The rest is based on color differences, which will be taken up in detail in another paper. The length of time for which off-season regenerants are retained is not known. It is probable that they are not held through the next annual molt.

The rectrices are shed and regenerated in the same sequence as occurs in the postjuvenal molt except that number six is more irregular. The order usually is: 2, 3, 4, 5 or 6, 1.

The time of completion of the annual molt varies with individual birds, falling between the middle of September and the latter part of October for *cafer* and *auratus*. The duration of the molt period for any single bird is thus about three months. Appar-

ently, either the primaries or the rectrices are the last of the flight feathers to complete molt.

No spring molt of flight feathers occurs in *Colaptes*, but at almost any time of year one or a few feathers may be lost and regenerated. This latter fact is abundantly illustrated by the presence in many birds taken in fall, winter, and spring, of feathers that are growing or that show less wear than the other members of the series. The phenomenon is sometimes symmetrical on the two sides of the body, sometimes not. What causes these feathers to drop at an off-season, I do not know. Some are probably knocked out by predators, but it is difficult to account for all by this means, especially in instances of symmetrical loss. It is probable that much of it is a response to internal stimuli. Regeneration apparently follows this off-season molt almost invariably, most of the new feathers being slightly shorter and narrower than feathers regenerated following normal molt. This usually can be shown by comparing the new feather with the older one on the other side of the body. The few examples given in the following table indicate the usual magnitude of difference. The newer (less worn) feathers are starred.

Table 1

Measurements in Millimeters of Flight Feathers Grown in Off-season (*) and at Annual Molt in *Colaptes cafer*

Specimen	Feather	Width		Length	
		Left	Right	Left	Right
No. 69375, Mus. Vert. Zool., May 26, 1936	rectrix 5	*14.9	18.9	*84	97
	rectrix 4	21.6	21.0	109	107
Field no. 687, F. H. Test Coll., April 8, 1938	rectrix 6	9.0	9.0	40.5	41.0
	rectrix 5	17.6	*18.0	107.6	*97.0
	rectrix 4	21.5	*21.1	108.4	*105.5
	rectrix 3	21.9	*21.2	112.0	*110.5
	rectrix 2	22.7	*22.3	112.8	*110.0
	rectrix 1	18.2	*17.8	114.0	*113.0
	secondary 4	21.8	*21.6	93.6	*95.0

Actual dates of off-season losses of feathers are difficult to determine unless the new feather is found while still growing. Usually the only certain indication that a particular feather has been grown at a time other than that of the annual molt is the difference in wear between it and the rest of the series. However, I have records of 21 specimens in which new feathers were actually being grown at the time of collection and after the bird had completed its normal molt program. The dates range through every month between annual molts. Mature, off-season feathers have been found in many other specimens.

RATE OF GROWTH OF INDIVIDUAL FEATHERS

Several flickers kept in captivity for studies of coloration afforded opportunity for learning something of the speed of growth of flight feathers. It is recognized that, for some purposes, studies of this sort made on captive birds are not as valuable as they would be if free-living subjects were used. However, studies on captives are important in interpreting *other* kinds of experimental data obtained from captive birds. This was true in the present situation.

The birds used were hand-fed in a small cage for one or two weeks until they learned to feed themselves, when they were released into an indoor flight cage measuring $12 \times 3 \times 8$ feet. They were fed on a mixture compounded in the following proportions: pheasant meal, 450 gm.; crissel, 150 gm.; ant "eggs" (= pupae), 50 gm.; dried "flies" (= ostracods or aquatic hemipterans), 50 gm.; rendered suet, 112 gm.; cod liver oil, 19 cc.; calcium lactate, 4 gm.; boiled potato or grated raw carrot root

equal to about one-half the volume of the preceding constituents. This mixture is modified from one kindly provided by Dr. G. B. Happ of Principia College. When uninjured and with relatively few ectoparasites, the flickers kept in good condition on this food.

A number of individuals, mostly *C. cafer collaris*, were used in measuring growth rate. Because of the birds' wildness, measurements were made at intervals of several days (usually three or four) and the rate per day for each interval computed on an average basis. Some measured feathers were grown in the course of normal molt; others regenerated following plucking. Only one feather had stopped growth at or before the time of the last measurement. It is a primary, to be identified in the following table by having the last two measurements equal.

Table 2

Measurements in Millimeters Showing Growth of Primaries in Captive *Colaptes*

Birds and feathers	Dates and measurements			
C. cafer collaris, ad. ♂, 34-307551	Mar. 7	9	20	25
Primary right 7	60	67	93	96
Rate of growth		3.5	2.4	0.6
C. cafer collaris, ad. ♂, 34-307556				
Primary left 8	....	69	93	
Rate of growth			2.2	
C. cafer collaris, ad. ♂, No. 2	July 30		Aug. 3	7
Primary left 8			13	35
Rate of growth				5.5
Primary left 7	56		77	95
Rate of growth		5.3		4.5
Primary right 7	50		73	91
Rate of growth		5.8		4.5
Primary right 6	116		126	126
Rate of growth		2.5		....
C. cafer collaris, ad. ♀, No. 4				
Primary left 5	33		60	75
Rate of growth		6.8		3.8
Primary left 4	90		100	108
Rate of growth		2.5		2.0
Primary right 5	35		60	76
Rate of growth		6.3		4.0
Primary right 4	96		104	110
Rate of growth		2.0		1.5
C. cafer collaris, ad. ♀, 34-307553	Aug. 30		Sept. 3	10
Primary left 7	45		63	90
Rate of growth		4.5		3.9
Primary right 7	56		....	97
Rate of growth			3.7	
C. auratus luteus, juv. ♀, "Blue"	Aug. 28		Sept. 9	
Primary left 7	15		77	
Rate of growth		5.2		
Primary right 7	11		74	
Rate of growth		5.3		
C. auratus luteus, ad. ♀	Sept. 25		Nov. 10	
Primary left 7	34		77	
Rate of growth		0.9		

The data in table 2 show that the rate of growth of primaries is greatest at first and gradually decreases as the feather becomes longer. The same thing is shown more clearly in figure 11, in which points are plotted from growth rates listed in table 2. In preparing figure 11, only those growth rates were used which had been determined from measurements made at intervals of five days or less; most of the intervals are three or

four days. A long interval would tend to mask changes in rate. There is apparent a straight-line decrease in growth rate with increase in length of the feather. In the early part of its growth a primary grows at a rate of about 6.7 mm. per day, with the rate decreasing to about 4.2 mm. per day at mid-length and to 1.2 mm. per day just before maturity is reached.

In general, difference in rate at the same stage of growth is relatively small among the middle primaries, even of different individuals. Some of the variation which is ap-

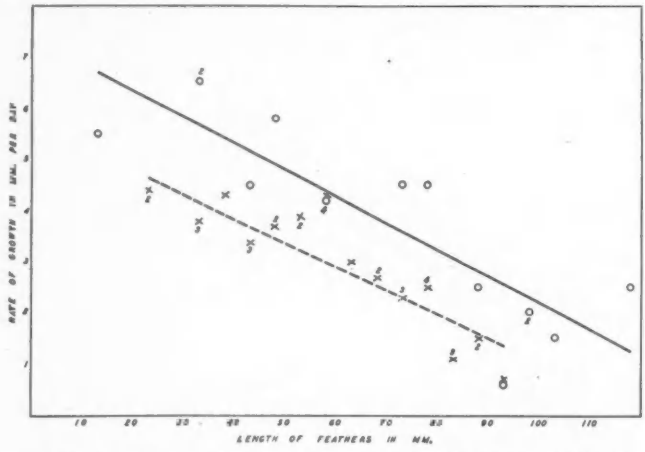


Fig. 11. Relation between rate and stage of growth in flight feathers of *Colaptes cafer collaris*. Circles and solid line, primary wing feathers; crosses and broken line, secondaries. Numerals beside points indicate number of data (different feathers) averaged in calculating each. Only rates of growth determined from measurements at intervals of five days or less are included.

parent probably is caused by differences in inherent factors, although sex seems not to be a cause. The data are too few to permit determination of this latter point. The birds differed in their states of health, to which can probably be attributed part of the variation in growth rate of their feathers.

Table 3

Measurements in Millimeters Showing Growth of Secondaries in Captive *C. cafer collaris*

Birds and feathers	Dates and measurements					
34-307556, ad. ♂			Mar. 9	Mar. 20		
Secondary right 2			62	84		
Rate of growth				2.0		
No. 2, ad. ♂	Apr. 24	27	May 1	July 30	Aug. 3	
Secondary left 2	24	36	56	....	....	
Rate of growth		5.0	4.3			
Secondary right 5	35	49	65	....	....	
Rate of growth		4.7	4.0			
Secondary right 1	....	....	....	78	92	
Rate of growth					3.5	
No. 4, ad. ♀						
Secondary left 5	21	32	45	....	....	
Rate of growth		3.7	3.3			

The data given in table 3 are not complete for any single feather and were taken at various stages of growth. Table 4 shows nearly the complete growth of four secondaries regenerated after plucking.

Table 4

Measurements in Millimeters of Growth of Secondaries, Following Plucking, January 23, in Two Captive *C. cafer collaris*

Birds and feathers	Dates and measurements								
No. 2, ad. ♂	Feb. 5	14	17	21	24	28	Mar. 1	4	6
Left 4	6	42	53	70	78	88	94	93	....
Rate		4.0	3.0	4.3	2.7	2.5	2.0		
Right 5	10	46	56	73	80	89	91	93	93
Rate		4.0	3.3	4.3	2.3	2.3	1.0	0.7	
No. 4, ad. ♀									
Left 4	3	35	45	62	71	80	83	88	88
Rate		3.6	3.3	4.3	3.0	2.3	1.5	1.7	
Right 5	6	42	53	67	75	84	85	88	88
Rate		4.0	3.0	3.5	2.7	2.3	0.5	1.0	

Measurements of secondaries (tables 3 and 4) show a decreasing rate of growth similar to that of primaries. A slower growth rate throughout is indicated for secondaries (figure 11). It appears to be about 4.5 mm. per day near the beginning, decreasing to 3.5 mm. at mid-growth, and being about 1.5 mm. in the last couple of days of growth.

Measurements of rectrices (table 5) are few and mostly taken at such long intervals as not to show a true picture of their rates of growth at different stages. They suggest, however, a slower growth than in flight feathers of the wing. This lower rate may result from inherent physiological differences, or might be caused, at least in part, by the bird's frequent and strenuous use of these feathers for support while they are growing. Growing wing feathers are, indeed, used in flight, but they usually are partially supported by adjacent feathers, whereas the pressure on the tail feathers is against the tip of each and is transmitted longitudinally to the growing and dividing zones of the feather and its papilla. The sudden and large changes in pressure and probable tearing effects in this region might have a direct, slowing effect on growth.

Table 5

Measurements in Millimeters of Growth of Rectrices in Captive *Colaptes*

Birds and feathers	Dates and measurements		Birds and feathers	Dates and measurements	
C. cafer collaris	March 9	20	*C. cafer collaris*	Sept. 3	10
34-307551, ad. ♂			34-307553, ad. ♀		
Left 2	57	65	Left 5	41	60
Rate of growth	0.7		Rate of growth	2.7	
34-307556, ad. ♂			Right 5	57	74
Right 2	55	77	Rate of growth	2.4	
Rate of growth	2.C		*C. auratus luteus*	Sept. 9	Oct. 4
Left 3	57	82	"Blue," juv. ♀		
Rate of growth	2.3		Left 5	25	50
Left 4	53	78	Rate of growth	1.0	
Rate of growth	2.3		Right 5	3.3	50
			Rate of growth	1.9	

Measurements of rate of feather growth appear to be rather scarce in the literature, and I have found none at all for woodpeckers. Sumner (1933) studied the growth of the juvenal sixth primary, first secondary, a tail feather, and the upper covert of each, in the Pacific Horned Owl (*Bubo virginianus pacificus*), Golden Eagle (*Aquila chrysaëtos canadensis*), and Barn Owl (*Tyto alba pratincola*). His histograms for single individuals show that the growth rate of all the coverts steadily decreased. A less rapid decrease took place in all the larger feathers except the rectrix of the owl

and the rectrix and primary of the eagle. These latter feathers held a nearly steady rate for the entire period of growth. Fragmentary data by the same author (1929) on the juvenal fifth primary of the Golden Eagle, Sparrow Hawk (*Falco sparverius*), and Pasadena Screech Owl (*Otus asio quercinus*) show a similar variation. The growth rate greatly decreased in the screech owl, decreased slightly in the eagle, and held about the same throughout the period of measurement in the hawk. It should be emphasized that these data refer to feathers of the first teleoptile (juvenal) plumage. My measurements on flickers were all of *regenerating* feathers (of postjuvenal or later generations).

Juhn, Faulkner, and Gustavson (1931) have published data on regenerating breast, back, and saddle feathers in the adult fowl (*Gallus domesticus*) following plucking. In the back and saddle feathers there was a remarkably uniform rate in each type. Breast feathers had a relatively uniform rate up to the period between 50 and 60 days of age, when their growth rate in the male decreased somewhat.

That actual rate of growth often is different between species, sexes, individuals, and types of feather is shown by the sets of data referred to above. The actual rates given by Sumner (1929) for the early growth of the fifth primary in the juvenal screech owl and sparrow hawk—species with body weights similar to that of the flicker—are about the same (a little lower) as those recorded here for the flicker. Juhn, Faulkner, and Gustavson (*loc. cit.*) found a significant sexual difference in rate of growth in the common fowl in feather regions where there is sexual dimorphism.

SUMMARY

Study of about 2500 flickers—living, dead, and as study skins—has shown certain previous conclusions regarding molt in these birds to be incorrect and has provided additional information.

Postjuvenal molt of primaries is complete and is initiated in the small, weak primary one, proceeding distally through the other primaries, in order. This process begins about the time the birds are fledged and before all feathers of the juvenal plumage are fully grown. The time of inception of molt differs between species and between individuals, depending probably upon the time of nesting of the adults. The annual (fall) molt of adults follows the same order as the postjuvenal molt; variations from that sequence are rare.

Despite assertions to the contrary, there is little or no postjuvenal molt of secondaries. The infrequent replacement which does occur at this time involves only a few proximal secondaries. This irregular molt is apt to be asymmetrical. Annual molt of secondaries begins about the time primary three is shed and usually follows the order: 8–9–7–6 or 10–1 or 2–3 or 11–5–4, but variation is frequent. Thus, molt is initiated in two centers—secondaries eight and one—with molt waves spreading both ways from the former and proximally from the latter. Approaching molt waves do not extend beyond the space between secondaries four and five and frequently do not meet, resulting in retention of one or more secondaries for an additional period beyond the usual twelve months. The molt wave from secondary one more commonly lags, with secondary four most commonly retained and numbers one and five least likely to be held over.

It is thought that the presence of two molt centers in the secondaries and the point of meeting of the approaching molt waves are causally related to the double embryonic origin of these groups of feathers. If this be true, there is here indicated an earlier embryonic determination of molt response than of feather type.

Molt of the rectrices usually begins when that of the primaries is about half completed. The sequence in the large feathers is 2–3–4–5–1. The small outer rectrix (num-

ber six) usually is shed first in postjuvenal molt but may be inserted anywhere in the series; in annual molt it is even more irregular in position in the molt sequence.

Colaptes has no regular spring molt of flight feathers, but a few feathers may be lost and regenerated at any time of year. Some of this loss probably is caused by forcible removal, but much of it appears to be a response to internal stimuli. Regenerants grown at these times are usually shorter and more narrow than normal.

Measurements of growing feathers have been made on captive flickers following postjuvenal and annual molt and experimental plucking. Primaries and secondaries show a steady decrease in growth rate as the feather lengthens; satisfactory data are not at hand for rectrices. Early growth rate in primaries is between five and seven millimeters per day, in secondaries between four and five millimeters per day. That of rectrices appears to be somewhat lower than in secondaries. Comparable data for other species are scarce but indicate differences dependent upon potentialities inherent in the species, sex, individual, age, and type of feather. Some feathers in other species have been shown by previous workers to have a relatively constant growth rate.

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LITERATURE CITED

Bent, A. C.
1939. Life histories of North American woodpeckers. U. S. Nat. Mus. Bull., 174:viii + 334 pp.
Burt, W. H.
1929. Pterylography of certain North American woodpeckers. Univ. Calif. Publ. Zool., 30:427-442.
Danforth, C. H.
1929. The effect of foreign skin on feather pattern in the common fowl (*Gallus domesticus*). Roux' Arch. f. Entwickl. Mech., 116:242-252.
Dwight, J., Jr.
1907. Sequence in moults and plumages, with an explanation of plumage cycles. Ornis, 14 (= Proc. 4th Internat. Ornith. Congr.):513-518.
Friedmann, H.
1930. The caudal molt of certain coraciiform, coliiform and piciform birds. Proc. U. S. Nat. Mus., 77:1-6.
Heinroth, O.
1898. Verlauf der Schwingen—und Schwanzmauser der Vögel. Sitzungsber. Gesell. Naturforsch. Freunde, Berlin, 1898:95-118.
Heinroth, O., and Heinroth, M.
1926-31. Die Vögel Mitteleuropas (Berlin, H. Bermühler), 4 vols.
Juhn, M., Faulkner, G. H., and Gustavson, R. G.
1931. The correlation of rates of growth and hormone threshold in the feathers of fowls. Jour. Exper. Zool., 58:69-111.
Miller, A. H.
1928. The molts of the loggerhead shrike, Lanius ludovicianus Linnaeus. Univ. Calif. Publ. Zool., 30:393-417.
1941. The significance of molt centers among the secondary remiges in the Falconiformes. Condor, 43:113-115.

Palmer, W.
1901. The malar stripe of young flickers and the molt. Osprey, 5:102-104.
Steiner, H.
1918. Das Problem der Diastataxie des Vögelflügels. Zeit. f. Naturwiss., 55:221-496.
Stone, W.
1896. The molting of birds with special reference to the plumages of the smaller land birds of eastern North America. Proc. Acad. Nat. Sci. Phila., 1896:108-167.
Sumner, E. L., Jr.
1929. Comparative studies in the growth of young raptores. Condor, 31:85-111.
1933. The growth of some young raptorial birds. Univ. Calif. Publ. Zool., 40:277-308.

Department of Zoology, University of Michigan, Ann Arbor, Michigan, and Museum of Vertebrate Zoology, Berkeley, California, January 3, 1945.

MAGGOT INFESTATION OF NESTLING MOURNING DOVES

By JOHNSON A. NEFF

In 1936 the writer became interested in the migration of Mourning Doves (*Zenaidura macroura*) in California and, with the aid of carefully selected cooperators, began the large-scale banding of nestling doves. Among the collaborators was Calvin Stevens of Le Grand, California, who stated that he had frequently found large maggots attacking nestling doves and mockingbirds. It was decided that a special study of maggot infestation in Mourning Doves be undertaken. With the assistance of Mr. Stevens, T. D. Southward of Le Grand, and L. E. Macomber of Modesto, the writer gathered data on the problem in Merced and Stanislaus counties in the San Joaquin Valley of California. Although the study as originally planned was never completed, some items of information obtained during the years 1936 to 1940 seem to merit publication.

Attack by maggots of blowflies (*Protocalliphora*) upon nestling birds has been reported in the literature. E. O. Plath, reporting on observations in the vicinity of Seattle (1919a) and Berkeley (1919b), listed nestlings of the Nuttall Sparrow, Song Sparrow, Robin, Willow Goldfinch, Green-backed Goldfinch, Cedar Waxwing, Russet-backed Thrush, Spotted Towhee, Brown Towhee, Cliff Swallow, Yellow Warbler, and House Finch as hosts of maggots. He concluded that the maggots preferred inhabiting moist fecal material; that at pupation they crawled down through this material to the bottom of the nest and attached themselves there; that dense nests were more heavily infested because maggots fell out of lighter nests; that maggots attack only at night or in poor light; and that partially grown maggots invariably died when removed from a source of food.

In the East, Johnson (1927) quotes Contant as concluding that the maggots attacked whenever hungry, and Stoner (1936) found that they fed freely during the day in nests of Bank Swallows. Thomas (1936) stated that tight nests or box nests were more heavily infested because maggots fell out of loose nests. At points in the East, at Seattle, and at Berkeley, investigators reported that many nestlings were killed by maggots. According to Thomas, parasites of the wasp family Chalcididae are a factor in control of maggots.

Species attacked.—In our studies, no maggots were found in the several nests inspected of the House Finch, Barn Swallow, Black Phoebe, Song Sparrow, Black-headed Grosbeak, Green-backed Goldfinch, Lawrence Goldfinch, nor in any of several thousand nests of Tri-colored and Red-winged blackbirds. Maggots were, however, found in the nests of English Sparrow, Mockingbird, California Shrike, Western Kingbird, and Mourning Dove. Of these, apparently the English Sparrow, California Shrike, Western Kingbird, and Mourning Dove had not been listed previously as hosts in the literature.

Season of infestation.—It appeared that the bulk of the attack occurred between May 20 and July 20. Many infested nests were found by June 1, while after July 10 it became increasingly difficult to find nests containing maggots.

Degree of infestation.—During 1938 and 1939 the infestation was severe. On one occasion in 1938, 12 nests out of 30 inspected were badly infested, while on another day 17 out of the 36 nests inspected were found infested. In 1939, out of 70 nests inspected, 37 were found infested. During the entire period, 1936-1940, in the course of banding

operations, we found that there was a high mortality in nestling doves, and our observations led us to suspect that this mortality might be attributed to the maggot infestion in large part.

From the flimsy nests of Mourning Doves the number of maggots obtained ran from a low of 20 to a high of 86, with the average running over 40. Obtaining mature maggots from such nests is simple, as it is only necessary to hold a hat or pan under the nest which is then moved gently. The maggots will roll off the supporting branch and out of the nest material into the container. Small immature maggots must be handpicked off the nestling.

Concealment.—In these frail nests the majority of maggots crawl down through the sparse material and rest on the top of the supporting branch. This location is never entirely dark during the day.

Manner of attack.—Small maggots were found in the ears, nostrils, among pinfeathers, on wings and tail, in angles of wings and legs, and occasionally elsewhere. On larger birds the more nearly mature maggots seemed to attack freely the ventral surface and the tarsi and feet.

Little visible effect was noted until the maggots were at least half-grown. Then attacks upon the tarsi showed plainly, with old wounds showing as small dark circular scabs one to two millimeters in diameter. Sometimes there would be as many as ten to each tarsus. Fresh wounds showed as small circular glistening spots where the exposed tissue had not yet formed scabs. In badly infested nests the ventral surface of the nestlings frequently was discolored with dried blood and maggot excreta, and at times even the nest material under the young birds showed the same discoloration.

When the maggots were hungry, they attacked at any time of day, though they preferred darkness or dull light. In one experiment maggots were fasted by removal of the nestlings and upon their replacement the maggots immediately crawled up through the nest and attacked, even in bright sunlight. Feeding to satiation was accomplished within as little as fifteen minutes, after which the maggots released their hold and a pin-head drop of blood appeared at the suction point. Some force was required to remove a hungry maggot when it had just begun to feed.

Action of infested doves.—On July 10, 1938, Stevens watched two nestling doves, evidently in discomfort, roll, kick, and squirm upon their frail platform. Picking them up he found five maggots attached to one of the nestlings. Next morning both were found dead beneath the nest, one with three maggots still attached, and it was inferred that both had fallen from the nest while trying to dislodge the maggots from bellies and legs. In other nests the nestlings were observed kicking about in identical manner.

In another experiment, large nestlings were removed from a badly infested nest and a three- or four-day-old nestling was substituted. It was quickly attacked and finally fell off the nest as it tried to move away from the attack. Close inspection disclosed small maggots in ears, nostrils, and among the pin-feathers. These were apparently the newly-hatched maggots that infested its own nest, not those that had attacked in the experimental nest.

A newly-deserted dove nest was removed intact from its location and placed in a small box. Using fresh groups of maggots to reinfest this nest from time to time, several Mourning Dove nestlings were placed in it and the box darkened with a cover. Upon each occasion the maggots crawled up through the nest and attacked the young dove. Under stress of this attack even four-day-old nestlings finally squirmed their way off the nest and onto the floor of the box, and older nestlings worked their way to the farthest corner. Maggots remained attached until the lid of the box was removed after

the nestling was heard scrambling about. When daylight entered the box, they usually dropped off the bird and tried to crawl to concealment.

One heavily infested nest was found in which one nestling showed signs of attack; the second nestling, in poor condition and marked by maggot attack, was on the ground underneath the nest still attended by one of the adult birds.

Moist fecal material had no part in the activity of the maggots. In the dry summer air of the San Joaquin Valley fecal material is rapidly desiccated and soon falls to the ground. Tests with moist pigeon fecal material aroused no activity among the maggots.

Effect upon doves. Banding studies in this section of California had disclosed a heavy loss in young doves. In one instance where careful records were kept, the young of only 18 nests out of slightly over 100 grew to bandable age. Other records showed similar heavy losses.

No dead nestlings were ever found in nests. Nestlings were seen to fall from their nests as they sought to dislodge the irritating maggots, and two were found dead on the ground soon after they had been seen fighting the maggots. Artificial tests had further proved that the young doves would scramble from the nest to avoid the attack.

Circumstances prevented determining the extent of the loss specifically due to this attack, but the writer feels that a considerable portion of the loss in young doves after hatching may be due to falling from the nest in trying to dislodge these maggots. Once on the ground there is little chance for survival, as feral house cats, skunks, opossums, snakes, and other predators are common in the area.

Pupation.—In the dense nests of other birds pupation occurs in the bottom layers of the nest material, but in the frail nests of the Mourning Dove no puparia were ever found. Under one badly infested nest the ground was hard, though covered with fully two inches of litter. A three-foot circle was drawn on the ground immediately under this nest and when the litter therein had been carefully removed puparia were found well scattered over the hard ground surface.

Another badly infested nest was located over well-disced soil, the top eight inches of which were soft, with hard soil underlying at the 8-inch level. A circle thirty-six inches in diameter was drawn about a point under this nest and the soil was then carefully removed, inch by inch. A total of 42 puparia was recovered, the majority of them lying between four and six inches deep in the soft soil. While a few were found in the upper four inches, more had penetrated to between six and eight inches, and none had gone into the hard plow-pan below the eight-inch depth. This observation was repeated with similar results.

Puparia hatched on the tenth day after pupation.

Species of fly.—Specimens from a number of the San Joaquin Valley nests were sent to Dr. David G. Hall of the U. S. Bureau of Entomology for identification. Those from nests of the mockingbird, shrike, kingbird, and sparrow were identified as *Protocalliphora metallica* (Townsend), one of the well-known and widely-distributed species, while all specimens collected from the nests of Mourning Doves and from the soil underneath these nests were identified as a new and undescribed species. In a revision of the blowfly family Calliphoridae now in press, Dr. Hall describes this new species and proposes a new generic name for the American blowflies heretofore assigned to *Protocalliphora*.

Natural controls.—Many maggots fall to the ground before maturity, and none of these survive. All fall to the ground to pupate. In numerous instances maggots were shaken to the ground for observation where large red and black ants abundant in the

area were seen to seize and carry them away. To this extent ants may well serve as a valuable check.

Some lots of puparia were found heavily infested with parasites, and in certain lots every individual was so affected. From puparia sent to him Dr. Hall identified this parasite as the chalcid wasp, *Mormomiella vitripennis*.

SUMMARY

Blowfly maggots parasitizing nestling Mourning Doves in the San Joaquin Valley of California were identified by Dr. David G. Hall as an undescribed species, while all those found in nests of other species of birds were identified as *Protocalliphora metallica*.

Attack of these maggots upon nestling Mourning Doves appeared to be an important factor in nest mortality in this area between 1936 and 1940. Nestlings fell to the ground as they attempted to dislodge the maggots. Specific studies on the extent of loss actually due to this factor were not made.

The frailty of nests of Mourning Doves does not appear to be a hindrance to this parasitism, since as many as 85 maggots were found in a single nest. When mature they fall to the ground and pupate under debris on top of hard soil, or in the top eight inches of soft soil. The pupal period was found to be ten days. Hyperparasites of the species *Mormomiella vitripennis* were abundant at times. Ants were seen carrying away maggots that had been shaken to the ground.

LITERATURE CITED

Plath, E. O.
1919a. Prevalence of *Phornia azurea* in the Puget Sound Region. Ann. Ent. Soc. America, 12: 373-381.
1919b. A muscid larva of the San Francisco Bay region which sucks blood of nestling birds. Univ. Calif. Publ. Zool., 19:191-200.

Johnson, C. W.
1927. The infestation of bluebird nests by *Protocalliphora*. Bull. N. E. Bird-Banding Assoc., 3:1-3.

Stoner, D.
1936. Studies on the bank swallow. Roosevelt Wildlife Annals, 4:216-219.

Thomas, E. S.
1936. Additional records of *Protocalliphora*. Bird-Banding, 7:46-47.

United States Fish and Wildlife Service, Denver, Colorado, January 15, 1945.

THE GOLDEN-CROWNED KINGLET OF SOUTHERN CALIFORNIA

By A. J. VAN ROSSEM

In the course of cataloging a collection of birds recently donated to this institution by James Stevenson, certain peculiarities shown by a breeding Golden-crowned Kinglet from the San Bernardino Mountains recalled to mind similar birds which previously had been examined from the central and southern Sierra Nevada, the San Gabriel Mountains and Mount Pinos. These had been tentatively identified as *Regulus satrapa apache*, a race then autotypically unknown to me, on the basis of large size and lighter coloration as compared with *olivaceus* of the Pacific northwest. Through the courtesy of Dr. L. B. Bishop, the Los Angeles Museum, the Museum of Vertebrate Zoology, the San Diego Natural History Museum, and Mr. George Willett, it has been possible to examine a fairly adequate series of *apache* (including the type) and also of the nominate race, *satrapa*, from the eastern United States. The Dickey Collections contain abundant material representing *olivaceus*, although many additional specimens have been examined in the collections enumerated above. It is now apparant that birds from southern California bear little resemblance to *apache* other than that they approach that race in size. A description of their distinguishing characteristics and other pertinent remarks follow.

Regulus satrapa amoenus, new subspecies

Sierra Golden-crowned Kinglet

Type.—Male of the year in complete, fresh, postjuvenal plumage; number 12993, Dickey Collections; collected at Lake Audrain, Eldorado County, California, August 19, 1923, by A. J. van Rossem.

Subspecific characters.—Larger in all dimensions than *Regulus satrapa olivaceus* Baird of the Pacific Northwest. Similar in general size to *Regulus satrapa satrapa* Lichtenstein of eastern North America and *Regulus satrapa apache* Jenks of southern Arizona, but bill longer than the former and slightly shorter than the latter. Coloration lighter and brighter than that of any previously described race: compared with *olivaceus*, lower back and rump close to "Warbler Green" instead of "Olive Green"; nuchal area paler and more ashy (less olive) gray; central crown patch of females and yellow portions of crown patch in males "Citron Yellow" or "Light Greenish Yellow" instead of "Wax Yellow" or "Stronian Yellow"; sides of head paler, with dark postocular mark obsolescent and superciliary stripes more prominently and more purely white; underparts paler (more like *satrapa* and *apache*) and lacking much of the buffy or olive wash present in *olivaceus*.

Range.—The Sierra Nevada of California, from Sierra County southward, Mount Pinos and the San Bernardino Mountains, and probably the San Jacinto Mountains. Apparently resident.

Specimens examined.—*Satrapa*, 30 from eastern United States; *apache*, 14 from Arizona and New Mexico; *olivaceus*, 56 from Alaska, British Columbia, western Washington, Oregon, and northern California south to central Siskiyou County (breeding), Alameda County (winter), Kern County (Piute Mts., winter), and Los Angeles County (winter); *amoenus*, 26 from Sierra, Eldorado, Mono, Kern, Los Angeles, and San Bernardino counties.

The species *satrapa* is distinct from the Old World *Regulus regulus* and *Regulus ignicapillus*. Although several attempts have been made to link *satrapa* with *regulus* the efforts do not seem to have met with complete success. It is suggested to those taxonomists who are obsessed with the notion that every geographic representative must be regarded as conspecific with *something* that they try a merger with *ignicapillus*. Lichtenstein originally compared *satrapa* with the latter species and his inferential guess at relationship would seem to be at least as good as the more recent one.

On the basis of characters of long bill and highly colored crown patch *apache* is a perfectly valid race, although otherwise it resembles *satrapa* far more closely than it does *olivaceus*. In the original description by Jenks (Condor, 38, 1936:239-244), this

was brought out clearly in the table of comparisons and in the "key," although Jenks, because of geographical considerations, compared it primarily with the latter race. The type series, most of which has been examined in the present study, is not in good condition for color comparison, but two males in the San Diego Natural History Museum from the White Mountains of Arizona, and a male and female in the Bishop Collection from Reserve, New Mexico, are so close to *satrapa* in general coloration as to be almost indistinguishable. Indeed, Dr. Bishop had so labelled the latter, previous to the description of *apache*.

Winter specimens from the lowlands of southern California have not been examined, although the species has several times been recorded from that area. I would rather expect them to be *olivaceus* since that race is known to be migratory. However, the only concrete instance of occurrences in southern California is a specimen in the Dickey Collection (number G-87) taken at the head of Bear Cañon, altitude 7000 feet, in the San Gabriel Mountains, on March 3, 1919, which is typical in color and in measurements (wing, 52 mm.; tail, 40) of *olivaceus*. Coastally, the southernmost winter specimen of that race examined is one taken at Berkeley, on November 27, 1903 (Loye Miller Collection).

The mensural differences between the several races of the Golden-crowned Kinglet are small, but they are remarkably uniform and, in combination with color characters, it is only rarely that a doubtful example is found; at any rate, such has been the writer's experience with the hundred-odd specimens examined at this time. Eight specimens from Idaho are excepted from this observation; they seem to be a little brighter colored than typical *olivaceus* but are similar to that race in size.

In the following table the wing measurements are very close to the results obtained by Jenks (*loc. cit.*). The tail measurements are shorter than his, presumably because of a different system of measurement. In the present case they are taken from the point of insertion of the central pair of rectrices to the tip of the longest rectrix. All measurements given here are taken from males.

24 *olivaceus* from Washington, Oregon, and northwestern California:
Wing, 52-55 (54.0); tail, 38-41 (40.4).
8 *apache* from southern Arizona and New Mexico:
wing, 56-58 (57.1); tail, 41-44 (42.2).
16 *amoenus* from California:
wing, 55-57 (56.3); tail, 40-45 (42.0).

The bills of these birds are too small for accurate measurement. I do not obtain the same figures as those recorded by Jenks for much the same material in the case of *apache*, and to avoid confusion neither his nor my measurements are cited. Visually, the bill of *olivaceus* is the smallest, that of *apache* the longest, and that of *amoenus* is intermediate but nearer to the second.

Dickey Collections, University of California, Los Angeles, California, February 5, 1945.

FROM FIELD AND STUDY

Osprey Nesting in Humboldt County, California.—A nesting pair of Ospreys (*Pandion haliaëtus*) have attracted the attention of visitors at Richardson Grove State Park in Humboldt County for several seasons. In 1943, one young was brought off the nest; in 1944, two young were reared successfully in the same nest and possibly by the same parents.

The nest was located on the west bank of the south fork of the Eel River about one mile north of Richardson Grove State Park headquarters and seven miles south of Garberville in southern Humboldt County. The nest was composed of a mass of sticks about five feet in diameter, resting upon the broken top of a Douglas fir snag, some two hundred feet above the ground. It was evidently cupped deeply since the adult birds occasionally disappeared completely from view after alighting upon the nest. This made it impossible to observe the young until they were old enough to climb up to the edge of the nest when they were nearly ready to fly, and then it became difficult to distinguish them from the parents. On August 4, 1943, I noted one young bird on a limb below the nest and at the same time could account for both parents in the air. Careful watching before and after that time did not give me any evidence of other young. The single young was reluctant to fly at first, but in two weeks it was making quite extensive flights. In the latter part of July, 1944, I identified two birds on the nest while both parents were in evidence elsewhere. By August 2, 1944, the young birds were on the wing making strong flights.

It is an interesting fact that although many people watched the adults as they circled about the nest or brought fish to the young or flew up and down the river, no one ever reported seeing the birds come down to catch fish. Possibly it is the habit of the Osprey to do its fishing at some distance from the nest.—HUBERT O. JENKINS, *Sacramento College, Sacramento, California, December 27, 1944.*

The Ruddy Turnstone in Utah.—The Ruddy Turnstone is apparently an irregular and rare migrant at the Bear River marshes of northern Utah. Archie V. Hull, who was formerly employed at the Bear River Migratory Bird Refuge, collected a male bird at the refuge on August 4, 1930. Dr. H. C. Oberholser carefully studied this specimen and identified it as *Arenaria interpres oahuensis*. Late in May, 1932, Messrs. Hull and V. T. Wilson of the refuge staff observed two turnstones. A few days later, Mr. Hull wrote that "knots and plovers lined the shoreline. . . . With Mr. Wilson we studied the two Ruddy Turnstones for a good hour through an engineer's level. They were in full breeding plumage." Mr. Hull noted three more birds on May 17, 1933. On May 28, 1944, Dr. E. R. Quortrup observed a turnstone on Willar Spur, outside Unit 5 of the Bear River Refuge.—CLARENCE COTTAM, *United States Fish and Wildlife Service, Chicago, Illinois, December 5, 1944.*

The Eastern Distributional Limits of the Anna Hummingbird in Winter.—Although by far the greater part of the population of the Anna Hummingbird (*Calypte anna*) is doubtless resident within the breeding range of the species in coastal and interior California, there is a definite, frequently noted, post-breeding exodus of uncertain degree from that area. The more distantly traveling individuals, as distinguished from the many which locally invade higher zonal levels in the fall, usually have been referred to as "vagrants," "casuals," or "accidentals," and perhaps some of the extreme northern records of this species fall into these categories. To the west, certain of the Santa Barbara Islands are part of the normal winter range, and there are various islands off the coast of Baja California where this hummingbird has been taken. The exact status of the Anna Hummingbird in these latter areas, however, is uncertain.

As one aftermath of recent field work in southern Arizona by Dr. Loye Miller and myself, I have collected all the data known to me concerning the occurrence of *Calypte anna* eastward into southern Arizona and northern Sonora. These are rather numerous when gathered together, and it is surprising to note that this species is listed only as a "casual" in Arizona in the 1931 edition of the A.O.U. Check-list. Moreover, Monson and Phillips (Condor, 43, 1941:109) have recently stated that there are "no published winter records for southern Arizona." As long ago as 1915, George Willett (Condor, 17, 1915:102) found the species "plentiful during [his] entire stay" at Roosevelt Lake from November 30 to February 3, but his record seems to have been overlooked. Our own observations, made between October 6 and 14, 1944, in the Pajaritos Mountains, which span the international boundary just west of Nogales, showed Anna Hummingbirds to be common and regularly distributed in the Emory oak belt (Upper Sonoran Zone). These birds did not behave in the restless manner usually characteristic of transients. On the contrary, we both got the impression that they were established territorially, at least for the time being. This was a fair assumption, for Dr. Miller and W. J. Sheffler

found them present, though rare, in the same locality (specifically Peña Blanca Spring) in February, 1941. We saw perhaps a dozen individuals a day, none of which were adult males. The three specimens taken on October 6, 7, and 10, respectively, were young of the year, one of which was so heavily soot-stained as to suggest that it had come from some heavily industrialized locality.

Records of occurrence east of the breeding range are listed below. All except those including year of record have appeared in easily accessible publications so that citations are not repeated here. They are available if desired. The arrangement is by seasonal date.

June 19 [1916]	Truckee, Nevada County, California	im. (Dickey Coll.)
August 7 [1921]	White Mountains, Mono County, California	im. (Dickey Coll.)
August 10	San José Mountains, Sonora	
September 4	Sacatón, Arizona	
September 11	Huachuca Mountains, Arizona	
September 24-27	Camp Grant, Arizona (5 specimens)	ad. and im.
October 1	Santa Catalina Mountains, Arizona	im.
October 8-14	Pajaritos Mountains, Arizona (common)	im.
October 14	"El Pinita" [Cerro de los Pinitos], Sonora	recorded as "*Calypte costae*"
November 30 to February 3	Roosevelt Lake, Arizona ("plentiful")	
December 3	Patagonia, Arizona	
December 14-18	Alamo Cañon, Arizona (2 specimens)	im.
December 18	Brawley, Imperial County, California	
December 24	Yuma, Arizona	ad.
December 25 to December 27 [1924]	Bard, Imperial County, California	(van Rossem notes)
January 2	Palm Springs, Riverside County, California	("a number")
January 4	Mecca, Riverside County, California	
February 2 [1941]	Pajaritos Mountains, Arizona	(L. Miller notes)
February 21	Punta Peñascosa, Sonora	
March 28 [1916]	Hesperia, San Bernardino County, California	ad. (Dickey Coll.)

It is evident from these records that a considerable number of Anna Hummingbirds migrate eastward across southeastern California as far as southeastern Arizona and northeastern Sonora, and that this movement starts (probably exceptionally) as early as the latter part of June. In the absence of records from Nevada, Utah, and northern Arizona, it is possible that a southward shift through California takes place prior to the eastward movement. During the fall most of the records are from the Upper Sonoran and Transition zones, and during the winter they are, with one exception, from the Lower Sonoran Zone. It should be noted that the bulk of the fall migrants are young birds, and that late winter and spring records are relatively rare.—A. J. VAN ROSSEM, *Dickey Collections, University of California, Los Angeles, December 13, 1944.*

The Inca Dove at State College, New Mexico.—During the summers of 1943 and 1944, a small number of Inca Doves (*Scardafella inca*) was observed on and near the campus of the New Mexico College of Agriculture and Mechanic Arts at State College in south-central New Mexico. These birds have not been reported from this part of the state to date, so far as is known to the author. According to Bailey's "Birds of New Mexico" (1928:306), they are quite uncommon in the state, having been recorded once at Silver City in 1924 and once 18 miles northwest of Lordsburg in 1926.

The presence of the birds at State College first became known to the writer on May 4, 1943, when one was heard giving the characteristic, double-noted *cooah-coo* call repeatedly. The birds were heard several other times during the summer of 1943 but were not seen clearly that year. In 1944 they were first heard on April 3, and one bird was seen on that date. On May 5 two were seen. On August 25 one was observed at Mesilla Park, about a mile west of the college campus. This bird was carefully and repeatedly observed at a distance of 50 to 75 feet with 8x binoculars. The long, square-tipped tail with white-margined outer feathers, wings showing brownish red in flight, and the heavily "scaled" back and scapulars served to identify the bird positively. One of the doves was heard on September 19 and 20 on the college campus and two were seen on October 17. Two were heard on November 2, 9 and 18, the last day in 1944 that any were seen or heard by the writer. No sign of mating or nesting activity was observed by the writer; however, no effort was made to determine whether or not nesting took place.

Professor Berry of the College Poultry Department states that the birds were commonly present about the poultry department farm during the summers of 1943 and 1944 and that they could be seen

each evening feeding on the ground in and near the poultry pens. He estimates that there were from 12 to 20 doves in 1944 and that there were more individuals in 1944 than in 1943. He observed no nesting or mating activities. His last observation of the birds in 1944 was made about December 1, when seven were seen feeding on the ground at the poultry farm.

No attempt has been made yet to take a specimen from the small flock on the college campus because it has been felt that the continued presence of these doves in this new location may be dependent, for the time being, on the survival and freedom from critical disturbance of a very few individuals.—K. A. VALENTINE, *State College, New Mexico, January 4, 1945.*

The Black Rail at Benicia, California.—On July 18, 1941, the shop foreman at the government arsenal in Benicia, Solano County, California, informed me that he had a strange small bird which one of the workmen had caught outside of the shop building. Upon seeing the bird, I recognized

Fig. 12. Black Rail caught at Benicia, California.

it to be a California Black Rail (*Creciscus jamaicensis coturniculus*), although I had never been fortunate enough to see this species before. It appeared possible that the bird had flown against the side of a tall, brick smokestack which rises from the edge of the salicornia-carpeted marsh along the Carquinez Straits and adjacent to the shop, as it was caught in a stunned condition.

My son improvised an outdoor cage for the bird and provided water and food which we thought might be acceptable. It ate nothing so far as we could observe and died on the third day after its capture. I preserved the skin, which is now in my collection.—EMERSON A. STONER, *Benicia, California, January 1, 1945.*

Three Species of Birds New to Boulder County, Colorado.—The following additions to the list of birds of Boulder County were made in the period from September, 1941, to September, 1943, when the writer was in residence at the University of Colorado.

Nyroca collaris. Ring-necked Duck. Niedrach and Rockwell (Birds of Denver and Mountain Parks, 1939:41) list several fall records and one spring record for areas adjoining Boulder County (Barr Lake, March 27, 1938). The Ring-necked Duck was first encountered by Miss Verna Mace and myself on April 5, 1942, on a small lake just east of the mouth of Deer Creek Canyon, fifteen miles southwest of Denver, Jefferson County; three pairs were observed.

The species was first observed in Boulder County on March 19, 1943, when two males and a female were seen on a small reservoir at the mouth of Twomile Canyon, just north of Boulder. This group was noted on several occasions. On April 11, 1943, two males were seen on a small lake about three miles south of Rabbit Mountain, just west of Longmont. On May 2, 1943, Miss Mace and I saw a single pair on Blue Mountain Reservoir, west of Berthoud, in Larimer County. On December 4, 1943, a female of this species was collected by Philip T. Frank five miles east of Boulder and is now mounted in the collection of the University of Colorado (no. 4252).

Buteo platypterus platypterus. Broad-winged Hawk. Niedrach and Rockwell (*op. cit.*:50) list several records of occurrence of this hawk in the spring at City Park, Denver, and they also have one specimen (Colo. Mus. Nat. Hist. no. 12386) taken May 12, 1933. On September 21, 1942, a single adult was observed flying over the campus of the University of Colorado in Boulder in company with two Marsh Hawks. The markings were familiar through long experience with this species in northern Ohio.

Psaltriparus minimus plumbeus. Lead-colored Bush-tit. According to Niedrach and Rockwell (*op. cit.*:119), this species "is only a wanderer in our territory." They mention two specimens taken

by Niedrach in City Park, Denver, in January, 1924, and on January 20, 1927. Bush-tits were encountered just southwest of Boulder, on the pediment of Bear Mountain, on November 11, 1941, when a flock of about ten was observed feeding in rock pines along with chickadees and nuthatches. Again on January 24, 1943, a small group of about six was seen about a half mile north of the mouth of Fourmile Canyon, north of Boulder. On April 11, 1943, a small group of Bush-tits was observed in Deadman Gulch, just off South St. Vrain Canyon, about three miles southwest of Lyons. It is possible that these birds are resident in suitable localities there. They are early nesters and the group encountered in April may have bred, or were breeding. These occurrences, both in spring and fall, of this bird should encourage further search to establish their seasonal status more accurately.—MALCOLM T. JOLLIE, *Museum of Vertebrate Zoology, Berkeley, California, December 20, 1944.*

Another Record of the Purple Gallinule in Arizona.—An uninjured adult female Purple Gallinule (*Ionornis martinica*) was taken on July 21, 1944, about 4 miles northeast of Tucson, Arizona. It was reported to me by a University watchman, Mr. Frye, on whose premises the family cat discovered it in hiding under a small palm, just after two or three days of high winds. A light mauling by the cat had resulted only in the loss of a few tail feathers.

There are now three authentic records of this species in Arizona backed by specimens in the University of Arizona collection. The first, an adult female, was taken at Tucson, September 30, 1887; the second, an adult male, was taken at Montana Lake, Oro Blanco, in western Santa Cruz County, on August 2, 1909. Both of these are in the Brown collection. To these the third, present specimen, is now added.

Doubt is cast by Allan Phillips (MS) on the claim, by Willard, of one taken at Tombstone in June, 1904 (Condor, 7, 1905:112). I think Phillips' point is well taken.—CHAS. T. VORHIES, *University of Arizona, Tucson, Arizona, November 22, 1944.*

Black-bellied Tree Ducks in Arizona.—At 7 a.m., on June 14, 1942, Mr. William X. Foerster of Tucson called me by phone to report the presence of two Black-bellied Tree Ducks (*Dendrocygna autumnalis*) on a small pond at Midvale Farms. This is on the west side of the Santa Cruz River, north of the San Xavier Mission, about 6 miles southwest of Tucson. Taking a shotgun I accompanied Mr. Foerster to the pond, where Mrs. Foerster had remained to watch the birds. On my arrival the ducks were, true to name, not on the water, but perched in a small mesquite tree which stood 4 or 5 feet above the surface of the pond. Supposing they were a pair, and since we had no specimens, both were collected.

Both were females, identical in length (470 mm.), and of nearly equal weight. One weighed 785 grams, the other 820 grams, or approximately one and three-fourths pounds each. They were not in breeding condition.

The rapidity with which the bright coral red faded from the beaks and legs was astonishing. This color had virtually disappeared by the time the birds were retrieved, indicating a probability that the red color of those parts is dependent on the capillary blood. No artist's representation that I have seen does justice to the brilliant red of those parts in the living bird.

While skinning the specimens I noticed that the flesh was tender and light in color like that of a young rabbit and quite unlike the dark meat of the common wild duck. The bodies were saved, prepared for the table, and proved to be most delicious meat, lacking the "wild" flavor common to other wild ducks. This characteristic was noted by Lawrence in 1874 (in Bent, U. S. Nat. Mus., Bull. 130, 1925:277) for the Fulvous Tree Duck.

This is the first record of this species in Arizona since 1906, when Herbert Brown reported as follows: "May 5, 1899, 6 out of a bunch of 8 Autumnal Tree Ducks (*Dendrocygna autumnalis*) were killed on the Santa Cruz, south of Tucson. They were the first and only ones I ever saw in Arizona. They were beautiful things" (Auk, 23, 1906:218). This statement certainly implies that Brown saw some of those birds while fresh. His own notes, however, now in our possession, show that he was in Yuma at the time the tree ducks were killed near Tucson. His notebook entry concerning them is under date of *October, 1901*, and reads as follows: "On May 5th, 1899, some 6 or 8 Autumnal Tree Ducks (*D. autumnalis*) were killed on the Santa Cruz river about 2 miles south of Tucson. I saw one in the possession of W. C. Brown and he informed me that a man by the name of Kelley had killed the others."—CHARLES T. VORHIES, *University of Arizona, Tucson, Arizona, February 20, 1945.*

NOTES AND NEWS

Frequently popular scientific publications carry articles stating that a goose, swan, condor, eagle or some other large bird (other than ostriches) has been known to break a person's arm or leg by a blow of the wing. We know of no well authenticated instance. This note is published at the suggestion of a reader in the hope that some of our Club members can adduce evidence on the subject.

The Museum of Vertebrate Zoology receives many inquiries about birds and other vertebrates from naturalists now in the armed forces. There also have been numerous requests for assistance in obtaining literature. Since entrance of our forces into the Philippines several requests have come for R. C. McGregor's "A Manual of Philippine Birds" and M. Hachisuka's "Birds of the Philippine Islands." The staff has been unable as yet to obtain copies of these works. If any Cooper Club member has copies which he is willing to loan or sell to service men in the South Pacific, please write to Seth B. Benson, Museum of Vertebrate Zoology, Berkeley, California, giving details as to price, and he will make the necessary arrangements as to payment and transportation. Do not send the books until notified unless they are to be gifts or loans. Any assistance in obtaining these and similar books will be appreciated by the men in the service.

A paper which may escape the notice of students of Pacific Coast ornithology is B. F. Osoria Tafall's "La Expedicion del M. N. 'Graciosa' por Aguas del Extremo Noroeste Mexicano" (Anales de la Escuela Nacional de Ciencias Biologicas [Mexico, D.F.], 3, 1944:331-360). This survey of guano production in northwestern Mexico contains many notes on the bird-life of islands near the peninsula of Baja California.—F.A.P.

PUBLICATIONS REVIEWED

A noteworthy contribution to western ornithology is A. M. Woodbury and H. N. Russell, Jr.'s, "Birds of the Navajo Country" (Bull. Univ. Utah, 35, 1945:1-160, 8 figures + map). This paper is essentially a faunal summation of the heretofore poorly known bird-life of southeastern Utah and northeastern Arizona. The authors and other field investigators whose names are listed participated in a series of "Rainbow Bridge-Monument Valley Expeditions" in the years 1933-1938. Their field data and specimens together with specimens in other collections and records in the literature form the basis of this report. Apparently most of the specimens collected by Woodbury *et al.* are deposited at the University of Utah.

The main text of this paper consists of species accounts in each of which are given, insofar as possible, a general statement as to relative abundance and local occurrence, a summary of specific observations, notes on nesting and habitat relations, and a list of specimens. Much worthwhile information is condensed in these accounts. The introductory section includes a historical resumé of expeditions and investigations, a separate chronological list of expeditions, brief descriptions of major habitats, and a check-list of species and races. All of the major climatic and vegetational zones of southwestern mountains are represented in the Navajo area, bounded, in general, to the west and north by the Colorado and the San Juan rivers, to the south by the Little Colorado, and to the east by the Carrizo and Lukachukai mountains. By my count, based on Woodbury and Russell's check-list, the avifauna of the Navajo region includes 92 nonpasserine and 115 passerine species. The status of 17 additional species is uncertain. The report is perhaps most valuable for information on the birds of the piñon-juniper woodland or "pigmy forest," which, "despite its irregularities, . . . seems to be more extensive and covers more area than any other single cover type in the Navajo Country." A bibliography and an index to common names are provided.—FRANK A. PITELKA.

MINUTES OF COOPER CLUB MEETINGS

NORTHERN DIVISION

JANUARY.—The regular meeting of the Northern Division of the Cooper Ornithological Club was called to order by President Robert C. Miller at 8 p.m., Thursday, January 25, in Room 2503 Life Sciences Building, University of California, Berkeley, with about 45 members and guests present. Two proposals for membership were read: Miss Lois Hanscom, 72 Panoramic Way, Berkeley 4, California, by Amelia S. Allen, and Mr. John B. Hamilton, Winchester Canyon, Goléta, California, by Richard M. Bond.

Dr. Benson, chairman of the nominating committee, reported the nomination of the following: for president, W. I. Follett; vice-president, Sumner C. Brooks; corresponding secretary, Hilda W. Grinnell; recording secretary, Alice S. Mulford. As there were no nominations from the floor, Lewis Taylor moved that the secretary be authorized to cast a unanimous ballot electing the nominees. The motion was seconded and

passed. Dr. Miller then greeted the new president and handed him the "Order of Business" as his badge of office.

Mr. Robert Storer mentioned an article by Walter A. Weber, "Wildlife of Tabasco and Vera Cruz," in the February National Geographic, which contains colored plates of birds. Dr. Benson reviewed Grinnell and Miller's "The Distribution of the Birds of California" and Ernst Mayr's "Birds of the Southwest Pacific."

Field observations included: a report by Dr. L. A. Elmore of a Fox Sparrow eating a laurel fruit on Rose Walk, Berkeley, and of a Horned Owl eating pigeons; announcement of a Short-eared Owl at the Aquatic Park on January 23 and 25 by Miss Grace Crowe; observation of a House Wren on the Berkeley Campus on January 21 by Mr. Robert Storer; Mrs. J. W. Kelly said Angelo Hewetson had seen 42 Semipalmated Plovers in Alameda on January 6 and she saw 40 the next day.

The speaker of the evening, Dr. Robert C. Miller, discussed "The Influence of Birds on Human Civilization," mentioning several historical incidents, including the importance of the study of bird flight in the development of the airplane in idea and actuality, ornithological references in common expressions and words, sociological and economic behavior of birds, and the benefits accruing to the individual human who takes an interest in birds.

Adjourned.—ALICE S. MULFORD, *Recording Secretary.*

SOUTHERN DIVISION

DECEMBER.—The regular monthly meeting of the Southern Division of the Cooper Ornithological Club was held on Tuesday, December 26, 1944, at 8 p.m., in Room 145, Allan Hancock Foundation, University of Southern California, Los Angeles, with A. J. van Rossem presiding and 20 members and guests present. The Secretary being absent, the President appointed George Willett to perform the duties of that office. The President then appointed Hildegarde Howard, Irwin D. Nokes and George Willett as a committee to submit nominations for officers for the coming year.

The first speaker of the evening was Dr. John E. Cushing, Jr., whose subject was "Traditions of Bird Behavior." Many phases of behavior, both traditional and inherited, were mentioned, among them being mating preference, reaction to enemies, ability to recognize danger calls, food preferences, etc. Also some features of behavior in their relation to evolution, and others in their relation to game management were discussed.

At the close of Dr. Cushing's talk and the discussion arising therefrom, the President introduced Mr. Telford H. Work, of the Northern Division, who had appeared unexpectedly, bringing with him several reels of fine colored motion pictures of birds. These included life history studies of Turkey Vulture, Prairie Falcon, Horned and Barn owls, and banding operations in the Caspian Tern colony on San Francisco Bay. They were excellently presented and much enjoyed.

Adjourned.—G. WILLETT, *Acting Secretary.*

JANUARY.—The regular monthly meeting of the Southern Division of the Cooper Ornithological Club was called to order by Vice-president Ed Harrison at 8 p.m., Tuesday, January 30, 1945, in Room 145, Allan Hancock Foundation, University of Southern California, Los Angeles. Proposals for membership were read from the following: Carl Stromgren, Box 742, Newton, Iowa, by W. Lee Chambers; James Robert Caldwell, Willow Creek, Alberta, Canada, by W. Lee Chambers; Bruce Arthur Krug, % International Pacific Salmon Fisheries Commission, Dominion Building, New Westminster, B.C., proposed by Theed Pearse; Byron E. Harrell, 1594 Stanford Avenue, St. Paul 5, Minnesota, by Mrs. N. Edward Ayer; Herbert Archibald Proctor, 1700 Monte Vista Street, Pasadena 4, California, by A. J. van Rossem; Harold Leader, 2830 Motor Ave., Los Angeles 34, California, by Walter W. Bennett; Fred F. Nye, Box 869, Brownsville, Texas, by Sidney B. Peyton; Mrs. Esther Sym Henrie, 466 Franklin St., Napa, California, by Mrs. Ruth Wheeler; Carlton M. Herman, 1060 Cragmont Ave., Berkeley 8, California, by Sherwin F. Wood; Paul Eugene Belcher, 988 Jefferson Ave., Akron 2, Ohio, by W. Lee Chambers; and Doris Huestis Speirs, 92 McIntyre St., W., North Bay, Ontario, Canada, proposed by John McB. Robertson.

New officers were unanimously elected for the year 1945 as follows: president, Walter W. Bennett; vice-president, Ed N. Harrison; secretary, Miss Dorothy Groner. Moved by C. V. Duff, seconded by Mrs. Mary V. Hood, and duly carried, that the membership express their appreciation for the good work during the past year of the retiring officers.

The discussion which followed centered about the subjects of ornithological journalism, field observations of members and future program material.

Adjourned.—WALTER W. BENNETT, *Secretary.*

For Sale, Exchange and Want Column.—Each Cooper Club member is entitled to one advertising notice in any issue of The Condor free. Notices of over ten lines will be charged for at the rate of 15 cents per line. For this department, address JOHN McB. ROBERTSON, Buena Park, California.

FOR SALE—Fifty years accumulation, from leaflets to books, in all branches of biology. Reports, proceedings, etc., U. S. Biological Survey, Smithsonian, National Museum and other museums, states, societies, etc.; exploration, travel, and big game hunting in many lands. State what branch you are interested in and send for price list.—J. A. LORING, *Box 182, Owego, New York.*

WANTED—For research purposes, separates and books in usable condition dealing with original descriptions and systematics of mammals of America north of Panama, particularly Mexico. Baird's Mammals of the Boundary; Mearns' Mammals of the Mexican Boundary; Gaumer's Mamiferos de Yucatan; wanted at reasonable prices. Send lists and prices.—SETH B. BENSON, *Museum of Vertebrate Zoology, Berkeley 4, California.*

WANTED—The following numbers of The Oologist: no. 7, vol. 34, 1917; no. 11, vol. 35, 1918; no. 11, vol. 36, 1919; no. 7, vol. 53, 1936; no. 2, vol. 56, 1939; no. 5, vol. 58, 1941; the following number of the Ornithologist and Oologist: no. 4, vol. 6, 1881. Cash or exchange if desired.—OLIN SEWELL PETTINGILL, JR., *Carleton College, Northfield, Minnesota.*

WANTED—Sets of bird eggs and scientific skins needed in my collection, in exchange for eggs and skins from this region, from both private collectors and museums. All letters answered.—JOHN B. HURLEY, *401 South 17th Ave., Yakima, Washington.*

WILL TRADE—For The Auk, previous to 1944, at ½ A.O.U. prices, or works on aviculture: Delacour's "Les Oiseaux and Agriculture"; Armstrong's "Hand-list of the Birds of Samoa"; Barbour's "Cuban Ornithology"; "Journals of John and William Bartram"; Bates' "Handbook of the Birds of West Africa"; Beebe's "Jungle Peace," "Jungle Days," and "Pheasants: their Lives and Homes"; Brehm's "Cassell's Book of Birds"; Buller's "Manuel of the Birds of New Zealand"; Butler's "Foreign Finches in Captivity"; Canby's "Walt Whitman"; Cory's "Birds of the Bahama Islands"; Fuertes and Osgood's "Artist and Naturalist in Ethiopia"; Hickey's "A Guide to Bird Watching"; Hudson's "British Birds"; Munro's "Birds of Hawaii"; Musgrove's "Waterfowl in Iowa"; Pearson's "The Bird Study Book"; Page's "Species which Have Reared Young in Captivity"; Palmer's "The Life of Joseph Wolf"; Ripley's "Trail of the Money Bird"; Sturgis' "Field book of Birds of the Panama Canal Zone"; Whymper's "Egyptian Birds"; Wood and Fyfe's "The Art of Falconry"; Whistler's "Popular Handbook of Indian Birds."—CARL STROMGREN, *Box 742, Newton, Iowa.*

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